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Title : Maritime navigation and radiocommunication equipment and systems – VHF radiotelephone equipment incorporating Class “D” Digital Selective Calling (DSC) – Methods of testing and required test results

### Introductory note

This CDV is a technical revision to 62238 following experience with the application of the first edition. The major changes are described in the Introduction.

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MARITIME NAVIGATION AND RADIOCOMMUNICATION  
EQUIPMENT AND SYSTEMS –****VHF radiotelephone equipment incorporating  
Class “D” Digital Selective Calling (DSC) –  
Methods of testing and required test results**

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International Standard IEC 62238 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
80/352/FDIS	80/359/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2008. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

## INTRODUCTION

The first edition of this International Standard was published in 2003 to specify VHF radiotelephone equipment that was compatible with the Global Maritime Distress and Safety System (GMDSS) but intended for fitting to vessels to which the International Convention on the Safety of Life at Sea (SOLAS) 1974 does not apply. Such vessels are typically small commercial vessels, pleasure vessels, fishing vessels, etc.

The emphasis of the standard was on simplicity of operation with the aim that it should take no longer than 10 min for an operator to learn to use the equipment. The standard used DSC controllers based on class D together with built in procedures to assist the operator in setting up calls.

Since 2003 some thousands of units have been manufactured to the standard and much experience gained. This edition revises the standard to add clarification to the requirements. In particular a check list of requirements has been added as an annex.

One area where problems of interpretation have been particularly encountered is in the coding of frequency information in the DSC call. A new subclause has been added at 5.6 to explain the requirement and the tests of 8.14 and 10.8 have been expanded to confirm this. To assist users, channel 72 has been specified in 4.5.2 as the default inter-ship working channel.

A practical problem that has been noted in the market has been caused by the different use of the VHF channels in different parts of the world. This edition adds a new annex giving details of European use and subclause 4.3 has been revised to make a requirement that the equipment is capable of working with all the US, Canadian and European channel sets.

To assist users in preventing unwanted interruption to their traffic due to automatic switching of channels, a default condition has been specified in 4.4 of automatic switching disabled.

The microphone sensitivity has been specified in 8.4 at a frequency of 1 kHz as experience has shown that the previous specification at lower frequencies reduces the performance of the equipment in noisy environments.

Requirements for minimum display sizes have been removed pending more experience in the market.

The previous requirement in 5.4 that DSC transmissions are inhibited until the ship's MMSI has been programmed has been extended to include DSC reception. This is intended to permit the use as a radiotelephone without DSC functions.

The previous annex C which described differences between the standard and previous regional standards in the USA and Europe has been deleted as being of historic interest.

## **MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS –**

### **VHF radiotelephone equipment incorporating Class “D” Digital Selective Calling (DSC) – Methods of testing and required test results**

#### **1 Scope**

This International Standard covers the minimum requirements for general communication for shipborne fixed installations using a VHF radiotelephone incorporating class “D” Digital Selective Calling.

These requirements include the relevant provisions of the ITU Radio Regulations, ITU-R Recommendations M.493-11 where class D is defined, and incorporate the relevant guidelines of the IMO as detailed in MSC/Circ. 803, MSC/Circ. 862 and Resolution MSC.131(75).

This standard also specifies technical characteristics, methods of measurement and required test results.

Recommended standards for equipment intended to work in high level electromagnetic environments are described and included in annex D.

#### **2 Normative references**

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60945, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*

IEC 61162-1, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 1: Single talker and multiple listeners*

IMO Resolution MSC.131(75):2002, *Maintenance of a continuous listening watch on VHF channel 16 by SOLAS ships whilst at sea and installation of VHF DSC facilities on non-SOLAS ships*

IMO MSC/Circ.803: *Participation of non-SOLAS ships in the Global Maritime Distress and Safety System (GMDSS)*

IMO MSC/Circ.862: *Clarifications of certain requirements in IMO performance standards for GMDSS equipment*

ITU Radio Regulations, Appendix 18: 1998, *Table of transmitting frequencies in the band 156 - 174 MHz for stations in the maritime mobile service*

ITU-R Recommendation M.493-11, *Digital selective-calling system for use in the maritime mobile service*

ITU-R Recommendation M.821-1: 1997, *Optional expansion of the digital selective-calling system for use in the maritime mobile service*

ITU-R Recommendation M.825-3, *Characteristics of a transponder system using digital selective calling techniques for use with vessel traffic services and ship-to-ship identification*

ITU-R Recommendation M.1084-4: 2001, *Interim solutions for improved efficiency in the use of the band 156 -174 MHz by stations in the maritime mobile service*

ITU-R Recommendation M.1371-1: 2001, *Technical characteristics for a universal shipborne automatic identification system using time division multiple access in the VHF maritime mobile band*

ITU-R Recommendation SM.332-4, *Selectivity of receiver*

ITU-T Recommendation E.161, *Arrangement of digits, letters and symbols on telephones and other devices that can be used for gaining access to a telephone network*

ITU-T Recommendation O.41: 1994, *Psophometer for use on telephone-type circuits*

### **3 Terms, definitions and abbreviations**

For the purposes of this document, the following terms and definitions apply.

#### **3.1 Definitions**

##### **3.2 3.1.1**

###### **class D**

equipment intended to provide minimum facilities for VHF DSC distress, urgency and safety as well as routine calling and reception, not necessarily in full accordance with IMO GMDSS carriage requirements for VHF installations (ITU-R Recommendation M.493-11)

##### **3.3 3.1.2**

###### **carrier frequency**

the frequency to which the transmitter or receiver is tuned

##### **3.4 3.1.3**

###### **frequency deviation**

the difference between the instantaneous frequency of the modulated RF signal and the carrier frequency

##### **3.5 3.1.4**

###### **G3E**

phase-modulation (frequency modulation with a pre-emphasis of 6 dB/octave) for speech

##### **3.6 3.1.5**

###### **G2B**

phase-modulation with digital information, with a sub-carrier for DSC operation

##### **3.7 3.1.6**

###### **modulation index**

the ratio between the frequency deviation and the frequency of the modulation signal



### 3.8 Abbreviations

AIS	Universal shipborne automatic identification system
DSC	Digital selective calling
e.m.f.	electromotive force
EPIRB	Emergency position-indicating radiobeacon
EUT	Equipment under test
FM	Frequency modulation
IF	Intermediate frequency
IMO	International Maritime Organization
MMSI	Maritime mobile service identity
RF	Radio frequency
r.m.s.	root mean square
SINAD	Signal + noise + distortion to noise + distortion
VHF	Very high frequency
VTs	Vessel traffic services

## 4 General and operational requirements

NOTE A check list for the requirements of this clause is given in annex C.

### 4.1 General

The manufacturer shall declare that compliance to the requirements of clause 4 is achieved and shall provide relevant documentation if requested.

### 4.2 Composition

The equipment shall, as a minimum, include

- a VHF radiotelephone transmitter;
- a VHF radiotelephone receiver;
- a channel 70 watchkeeping facility for DSC decoder;
- a DSC encoder; and
- a DSC decoder.

### 4.3 Construction

The mechanical and electrical construction and finish of the equipment shall conform in all respects to good engineering practice, and the equipment shall be suitable for use on board vessels.

All controls shall be of sufficient size to enable the usual control functions to be easily performed and the number of controls should be the minimum necessary for simple and satisfactory operation.

Adequately detailed operating instructions shall be provided with the equipment.

The equipment shall be capable of operating on single frequency and two-frequency channels with manual control (simplex).

The equipment shall be able to operate on all channels defined in appendix 18 to the Radio Regulations (see Annex E and ITU-R Recommendation M.1084-4). Additionally the equipment shall be able to operate on VHF channels outside those defined by appendix 18 which are permitted by Administrations for regional use (see for instance Annexes F, G and H). The equipment shall be capable of being provided with stored channel sets of these regional variations. Means shall be provided to ensure that the user is notified of the set in use.

If the equipment has facilities which allows the user to select these stored channel sets means shall be provided to block user access to any set, as may be required by appropriate Administrations before installation on board vessels.

In the case of an incompatible working channel request, for instance a request for a channel which is not included in the channel set in use, the unit shall reply "Unable to Comply" with 104 as the first telecommand and 108 as the second telecommand.

The equipment shall be so designed that use of channel 70 for purposes other than DSC is prevented.

It shall not be possible to transmit while any frequency synthesizer used within the transmitter is out of lock.

It shall not be possible to transmit during channel switching operations.

#### **4.4 Controls and indicators**

The user shall not have access to any control which, if wrongly set, might impair the technical characteristics of the equipment.

If the equipment can be operated from more than one position, the control unit provided at the position from where the vessel is normally navigated shall be capable of having priority and the individual control units shall be provided with an indicator showing whether the equipment is in operation.

The following controls or functions shall be provided:

- DISTRESS BUTTON (see 4.5.3);
- CALL (see 4.5.1);
- CANCEL to revert to the initial display or to silence the aural alarm and visual indication used to indicate receipt of a DSC alert. The cancel function shall take place automatically after a maximum of 5 min of inactivity;
- ENTER/Accept/OK for accepting a menu item;
- a means of easily entering a MMSI for calling and manual position information. If a numeric key pad is provided this shall conform to ITU-T Recommendation E.161;
- ALPHA – NUMERIC DISPLAY (see 4.6);
- on/off switch for the entire installation with a visual indication that the installation is in operation;
- a manual non-locking push-to-talk switch to operate the transmitter with a visual indication that the transmitter is activated and facilities to limit the maximum transmission time to 5 min;
- a switch for reducing transmitter output power to no more than 1 W, on both telephony and DSC, with a visual indication that low power is selected. Transmission of DSC distress calls shall always be at full power;
- an audiofrequency power volume control;
- a squelch control;

- a control for dimming to extinction the equipment illumination with the exception of a visual indicator (see 4.5.3).

The equipment shall have means to select manually a channel and shall indicate the designator of the channel at which the installation is set.

Selection of channel 16, shall be preferably by readily accessible means (e.g. a distinctively marked key). Selection of Channel 16 by any means shall automatically set the transmitter output power to maximum. This power level may subsequently be reduced by manual user control if required.

A means shall be provided for enabling the capability for automatically switching a radiotelephone channel when a channel change is requested (see 4.5.5). The default condition shall be that the automatic switching capability is disabled for all types of calls.

All electronic displays, including the channel designator, shall be legible irrespective of the external lighting conditions.

## **4.5 Facilities for coding and decoding of DSC**

### **4.5.1 Call functions**

The facilities for coding and composition of calls shall be so arranged that it is possible for the operator quickly and precisely to enter a call. The types of DSC calls provided in this equipment shall be as specified in annex A (see also 4.5.6).

The CALL functions (see 4.4) shall permit selection of the following functions:

- INDIVIDUAL: for making a call to a specific MMSI;
- GROUP: for making a call to a specific Group MMSI (see 5.4);
- ALL SHIPS URGENCY/SAFETY: for making all ships calls;
- RECEIVED CALLS: for retrieving stored incoming DSC calls;
- OTHER: for equipment housekeeping functions.

The default (initial display) shall be an individual call

If INDIVIDUAL is selected, either a MANUAL call (see 4.5.2) or a DIRECTORY call shall be capable of being selected. The DIRECTORY list shall have a facility for at least 10 entries. Their MMSIs shall be programmable.

### **4.5.2 MANUAL calls**

The MANUAL call facility shall permit the entry of a MMSI. If the called station is a coast station (i.e. MMSI commencing 00) no further information shall be requested from the operator. If the called station is a ship station the equipment shall request input of a working channel number. The equipment shall assist the operator by making available an inter-ship channel suitable for the vessels area of operation. Channel 72 shall be the default channel.

NOTE In Appendix 18 of the Radio Regulations channels 6, 8, 72 and 77 are reserved solely for inter-ship communications. Channels 9, 10, 13, 15, 17, 67, 69 and 73 may also be used for inter-ship communications but are also available for port operations and ship movement. Other uses of the channels are described in annexes F and G.

### **4.5.3 Distress calls**

It shall only be possible to transmit distress DSC calls by means of a single dedicated button which is used for no other purpose. This button shall not be any key of ITU-T Recommendation E.161 digital input panel or an ISO keyboard provided on the equipment. This button shall be red in colour and marked "DISTRESS". Where a non-transparent protective lid or cover is used, it shall also be marked "DISTRESS". The cover shall be protected against

inadvertent operation with a spring loaded lid or cover permanently attached to the equipment by, for example hinges. It shall not be necessary for the user to remove seals or to break the lid or cover in order to operate the distress button.

The operation of the distress button shall generate a visible and audible indication (see 5.7.3). The distress button shall be kept pressed for at least 3 s. A flashing light and an intermittent acoustic signal shall start immediately. After the 3 s, the transmission of the distress alert is initiated and the indication shall become steady.

The distress alert initiation shall require at least two independent actions. Lifting the protective lid or cover is considered as the first action. Pressing the distress button is considered as the second independent action.

It shall be possible to select the nature of distress prior to initiating the transmission of a distress call. The default nature of distress shall be the undesignated distress. The equipment shall be capable of receiving and displaying any designated nature of distress, but shall not be capable of transmitting a nature of distress of EPIRB (symbol 112).

Initiation of a distress call shall automatically have priority over any other operation of the equipment. The equipment shall automatically select channel 70 and the maximum transmitter power.

The distress call shall automatically be transmitted five times in succession with no intervals between the individual calls so that bit synchronization between the transmitter and receiver of the call can be maintained. Each call shall include the appropriate dot pattern.

Following the distress call sequence, a DSC expansion message giving enhanced position resolution according to ITU-R Recommendation M.821-1 shall be transmitted.

After the transmission of the distress call sequence, including the DSC expansion message, the equipment shall automatically tune to channel 16 and select the maximum transmitter power.

#### **4.5.4 ALL SHIPS calls**

It shall only be possible to transmit ALL SHIPS URGENCY and ALL SHIPS SAFETY calls by means of deliberate actions, such as two levels of menu instructions.

After the transmission of the all ships call, the equipment shall automatically tune to channel 16 and select the maximum transmitter power.

#### **4.5.5 Incoming calls**

The DSC equipment shall be provided with suitable facilities for converting incoming calls with relevant address content to visual form in plain language. The contents of at least the last 10 received DSC calls shall be stored in the RECEIVED CALL menu.

The radiotelephone shall be capable of automatically switching to any channel identified in an incoming call. In the case of incoming distress and urgency calls the radiotelephone shall be capable of automatically switching to channel 16 and automatically selecting the maximum transmitter power. The user shall be provided with a visual indication that a channel change is requested (See also 4.4).

#### **4.5.6 Other calls**

It is recommended that call types in addition to those specified in annex A are not provided in order to not complicate the operation of the radiotelephone for users.

Calls of type "All ships routine" and "Distress cancellation" shall not be provided.

If automatic response to polling or position reporting calls is included, means for disabling those responses shall be provided.

#### **4.6 DSC display**

The equipment shall be provided with facilities which show the functions currently available, prompts the operator if an incorrect operation is attempted, displays error messages and displays incoming and logged calls.

The equipment shall be provided with facilities for visual indication, and possible manual correction of the user programmable information content of the call before the call is sent.

There shall be an indication that unread received (see 4.5.5) messages are present in memory.

Display of geographic position and time shall be readily available. The equipment shall be provided with facilities to display the last entered position (see 5.5). The DSC display should be capable of continuously displaying a complete enhanced position according to ITU-R M.821.

#### **4.7 Handset and loudspeaker**

The equipment shall be fitted with a telephone handset or microphone, and an integral loudspeaker and/or a socket for an external loudspeaker. Where there are connections to external loudspeakers, these shall also relay acoustic alarms.

During transmission in simplex operation the receiver output shall be muted.

#### **4.8 Safety precautions**

Measures shall be taken to protect the equipment against the effects of excessive current or excessive voltage.

Measures shall be taken to prevent any damage that might arise from an accidental reversal of polarity of the electrical power source.

Means shall be provided for earthing exposed metallic parts of the equipment.

The components and wiring in which the a.c. or d.c. voltage (other than radio-frequency voltage), produce, singly or in combination, peak voltages in excess of 50 V, shall be protected against any accidental access and shall be automatically isolated from all electrical power sources if the protective covers are removed. Alternatively, the equipment shall be constructed in such a way as to prevent access to components operating at such voltages unless an appropriate tool is used such as a nut-spanner or screwdriver. Conspicuous warning labels shall be affixed both inside the equipment and on the protective covers.

No damage to the equipment shall occur when the antenna terminals are placed on open circuit or short circuit for the period permitted by the push-to-talk switch in 4.4.

In order to provide protection against damage due to the build up of static voltages at the antenna terminals, there shall be a d.c. path from the antenna terminals to chassis not exceeding 100 kΩ.

The information in programmable memory devices and the vessel's identity and information inherent to the DSC process shall be stored in non-volatile memory devices.

#### **4.9 Labelling**

All controls, instruments, indicators and terminals shall be clearly labelled.

Details of the power supply from which the equipment is intended to operate shall be clearly indicated on the equipment.

Details of manufacturer, type designation and serial number shall be indicated.

The compass safe distance shall be stated on the equipment or in the user document as described in IEC 60945.

#### **4.10 Warm up**

After being switched on, the equipment shall be operational within 5 s.

### **5 Technical requirements**

**NOTE** The manufacturer shall declare that compliance to the requirements of this clause which are not subject to the tests of clauses 8, 9 and 10 is achieved and shall provide relevant documentation if requested. A check list is given in annex C.

#### **5.1 Switching time**

The channel switching arrangement shall be such that the time necessary to change over from using one of the channels to using any other channel does not exceed 5 s.

The time necessary to change over from transmission to reception or vice versa, shall not exceed 0,3 s.

#### **5.2 Class of emission and modulation characteristics**

The equipment shall use phase modulation, G3E (frequency modulation with pre-emphasis of 6 dB/octave) for speech, and G2B for DSC signalling.

The equipment shall be designed to operate with a channel separation of 25 kHz. Other channel spacings are allowed if permitted by appropriate national Administrations (see ITU-R Recommendation M.1084-4).

#### **5.3 Facilities for DSC transmission and reception**

##### **5.3.1 General**

The equipment shall include the necessary facilities for coding and transmission of DSC on channel 70 and for decoding and conversion of the information content of received DSC.

The watchkeeping facility part of the DSC equipment shall be designed for continuous DSC monitoring on channel 70 but need not operate when the transmitter is in use.

##### **5.3.2 Decoding**

The DSC equipment shall be so designed that in the decoding process use shall be made of the phasing sequence, of parity bits for error detection, time diversity repetitions and error check characters in the received call as specified in ITU-R Recommendation M.493-11.

### **5.3.3 Free channel transmission**

The DSC equipment shall be provided with facilities which, except for distress calls, automatically delay the transmission of DSC until the calling channel 70 is free.

### **5.3.4 Automatic acknowledgement**

The equipment shall not be provided with facilities for automatic transmission of acknowledgements to routine calls.

### **5.3.5 Automatic re-transmission of distress calls**

Where no DSC distress acknowledgement is received, the equipment shall automatically retransmit the distress call attempt on channel 70 after a random delay of between 3,5 min and 4,5 min from the beginning of the previous call.

After the transmission of each distress call attempt the equipment shall automatically re-tune to channel 16 and select the maximum transmitter power.

This sequence shall be continued until a DSC distress acknowledgement has been received, or until the automatic transmission of the distress call is discontinued manually. This manual operation shall not interrupt the transmission of any distress call attempt in progress.

A visual indication shall be provided that a distress alert is in automatic retransmit mode. An audible indication shall be provided during retransmission.

## **5.4 Ships identity – MMSI and Group MMSI**

The equipment shall be capable of storing permanently the ship's 9-digit Maritime Mobile Service Identity (MMSI) number which shall be inserted automatically in the call. The 10th digit shall be added automatically and set to zero.

It shall not be possible to transmit or receive a DSC call until the ship's MMSI has been stored.

**NOTE** This requirement provides the option of using the equipment as a VHF radiotelephone without the DSC functions in installations having more than one VHF radiotelephone.

After the MMSI has been stored, it shall not be possible to change the identity number using any combination of operator controls. The ship's MMSI shall be readily accessible to the operator, either displayed at equipment power-up, or by a simple action of the operator.

Facilities shall be provided to permit the operator to program and store a Group MMSI number to enable the equipment to recognize calls addressed to both the ship's MMSI and the Group MMSI. These facilities shall limit the number of operator programmable digits to 8 and the leading zero shall be automatically inserted by the equipment.

## **5.5 Entry of position information**

Means shall be provided for manual entry of the geographical position information and of the time when this position information was valid. In addition, facilities for automatic entry and encoding of the geographical position and time information shall be provided. Such facilities, if provided externally shall conform with IEC 61162-1. As a minimum, the sentences GLL, GGA, RMC and GNS shall be recognized.

No connection of, or failure within, any connected equipment shall disable the DSC equipment.

When no position information has been entered either manually or due to the failure of any automatic system or the absence of a valid external data stream (IEC 61162-1), the operator

shall be aurally and visually prompted for a manual input of position. This prompt shall be repeated every 4 h.

If the position information has not been updated for 23,5 h, the position shall default to the repeated digit “9” as specified in ITU-R Recommendation M.493-11.

## 5.6 Channel information

Channel information shall be coded according to ITU-R Recommendation M.493-11 and ITU-R Recommendation M.1084-4. For single frequency channels in appendix 18 to the Radio Regulations (see Annex E) the digit “M” shall be “0”. For two frequency channels used as two frequency according to the appendix the digit “M” shall be “0”. For two frequency channels used as single frequency the digit “M” shall be “1” if the ship station transmit frequency is used and “2” if the coast station transmit frequency is used. Examples are given in table 1.

**Table 1 – Examples of coding of channel information**

Channel	Transmitting frequencies MHz		HM	TM	M	H	T	U
	Ship Stations	Coast Stations						
<b>1</b> (International) Two frequency use of two frequency channel	156.050	160.650	9	0	0	0	0	1
<b>1A</b> (US) Single frequency use of two frequency channel – ship transmit frequency	156.065	156.065	9	0	1	0	0	1
<b>1</b> Single frequency use of two frequency channel – coast transmit frequency	160,650	160.650	9	0	2	0	0	1
<b>72</b> (International) Single frequency channel	156.625	156.625	9	0	0	0	7	2

In order to achieve compatible operation with older designs the receiver shall correctly identify two frequency use of a two frequency channel when the digit “M” is any digit other than “1” or “2” and a single frequency channel when the digit “M” has any value. Examples are given in table 2.



**Table 2 – Required receiver characteristics for correct channel selection**

Channel	Transmitting frequencies MHz		HM	TM	M	H	T	U
	Ship Stations	Coast Stations						
<b>1</b> (International) Two frequency use of two frequency channel	156.050	160.650	9	0	X	0	0	1
<b>1A</b> (US) Single frequency use of two frequency channel – ship transmit frequency	156.065	156.065	9	0	1	0	0	1
<b>1</b> Single frequency use of two frequency channel – coast transmit frequency	160.650	160.650	9	0	2	0	0	1
<b>72</b> (International) Single frequency channel	156.625	156.625	9	0	y	0	7	2
NOTE                      x        any digit except 1 or 2 y        any digit								

## **5.7 Alarm circuits for incoming calls**

### **5.7.1 Distress and urgency**

The equipment shall be provided with a specific acoustic alarm and a visual indication, activated automatically when a call with format specifier distress or category distress or urgency has been received. It shall not be possible to disable these alarm circuits.

The alarm for distress and urgency calls should be distinguishable from the tone for safety and routine calls. The alarm should not be activated where duplicate distress relay calls are received within 1 h. A duplicate distress relay call is one having format specifier all ships or geographic area that contains identical message information to that of the initiating distress alert, and an identical distress MMSI.

### **5.7.2 Other categories**

The equipment shall be provided with an acoustic alarm and a visual indication, activated automatically on receipt of calls of categories other than distress and urgency. It shall not be possible to disable the acoustic alarm circuit.

### **5.7.3 Cancellation of alarms**

A means of manual cancellation of alarms shall be provided. In the event that an alarm is not cancelled manually, then automatic cancellation shall take place after 2 min.

### **5.7.4 Acoustic alarm power**

The acoustic alarm shall initially be of a power that is clearly distinguishable, but not interfere with, radiotelephone communications. If not manually cancelled within 10 s, the power should rise to a level of at least 80 dB(A) at a distance of 1 m from the equipment before automatic cancellation.

## **5.8 Multiple watch facilities**

### **5.8.1 General**

The VHF radiotelephone equipment may be provided with multiple watch facilities on traffic channels but operation using DSC shall always take precedence.

### **5.8.2 Scanning provisions**

Equipment having multiple watch facilities shall as a minimum comply with the following:

- the equipment shall include a provision for the automatic scanning of a priority channel and one additional channel. Facilities for the automatic sequential change of the additional channel may be provided;
- the priority channel is that channel which will be sampled even if there is a signal on the additional channel and on which the receiver will lock during the time a signal is detected;
- the additional channel is that channel which will be monitored during the periods the equipment is not sampling or receiving signals on the priority channel;
- provision shall be included to switch the scanning facility on and off by means of a manually operated control. In addition, it shall be ensured that the receiver remains on the same channel as the transmitter for the entire duration of any communication, for example the scanning facility may be switched off automatically when the handset is off its hook;
- selection of the additional channel and selection, if provided, of the priority channel shall be possible at the operating position of the receiver or transceiver. If selection of the priority channel is not provided, the priority channel shall be channel 16;
- when the scanning facility is in operation, the channel number of both channels on which the equipment is operating shall be indicated;
- in a transceiver, transmission shall not be possible when the scanning facility is operating. When the scanning facility is switched off, both transmitter and receiver shall be tuned automatically to the selected additional channel;
- a transceiver shall be provided with a single manual control (e.g. push-button) in order to switch the equipment quickly for operation on the priority channel;
- at the operating position of a transceiver, the selected additional channel shall be clearly indicated as being the operational channel of the equipment.

Additional scanning modes are permitted.

### **5.8.3 Scanning characteristics**

When the scanning facility is switched on, the priority channel shall be sampled with a sampling period of not more than 2 s.

If a signal is detected on the priority channel the receiver shall remain on this channel for the duration of that signal.

If a signal is detected on the additional channel, the sampling of the priority channel shall continue, thus interrupting the reception on the channel for periods as short as possible and not greater than 150 ms.

The design of the receiver shall provide for its proper functioning during the period the priority channel is sampled since the receiving conditions on the priority channel may differ from those on the additional channel.

In the absence of a signal on the priority channel, and, during reception of a signal on the additional channel, the duration of each listening period on this channel shall be at least 850 ms.

Means shall be provided to indicate the channel on which a signal is being received.

## **5.9 Built-in test**

A built-in test facility for the DSC processor shall be provided.

# **6 General conditions of measurement**

## **6.1 Arrangements for test signals applied to the receiver input**

Test signal sources shall be connected to the receiver input in such a way that the impedance presented to the receiver input is 50  $\Omega$ , irrespective of whether one or more test signals are applied to the receiver simultaneously.

The levels of the test signals shall be expressed in terms of the electromotive force (e.m.f.) at the terminals to be connected to the receiver.

The nominal frequency of the receiver is the carrier frequency of the selected channel.

## **6.2 Squelch**

Unless otherwise specified, the receiver squelch facility shall be made inoperative for the duration of the conformance tests.

## **6.3 Normal test modulation**

For normal test modulation, the modulation frequency shall be 1 kHz and the frequency deviation shall be  $\pm 3$  kHz.

For DSC conformance testing and maintenance purposes, the equipment shall have facilities not accessible to the operator to generate a continuous B or Y signal and dot pattern.

Additionally for conformance testing, the VHF equipment shall have facilities not accessible to the operator for generating an unmodulated carrier.

## **6.4 Artificial antenna**

When tests are carried out with an artificial antenna, this shall be a non-reactive, non-radiating 50  $\Omega$  load.

## **6.5 Arrangements for test signals applied to the transmitter input**

For the purposes of this standard, the audiofrequency modulating signal applied to the transmitter shall be produced by a signal generator applied to the connection terminals replacing the microphone transducer.

## **6.6 Test channels**

Conformance tests shall be made on channel 16 for voice and channel 70 for DSC tests, unless otherwise stated.

## **6.7 Generation and examination of the digital selective call signal**

During conformance tests DSC signals generated by the equipment under test shall be examined for correct format and phasing. The equipment used for this purpose should be capable of decoding the DSC call and displaying the content of the sentence as 10 bit symbols as well as the correctly decoded message. A means to produce a hard copy of the results shall be provided.

In addition, a DSC generator shall be used to provide DSC calls to the equipment under test. This generator shall be capable of generating both correctly formatted calls as well as calls containing bit errors in the primary code or the error check character. Tests shall be carried out to determine that the correct use of the error correction as defined in ITU-R M.493-11.

The test report shall identify the means used to determine the validity of the transmitted calls and the tests carried out to determine the ability of the receiver to provide maximum utilization of the received signal.

## 6.8 Standard test signals for DSC

The standard test signal for a VHF DSC decoder shall be a phase-modulated signal at VHF channel 70 with modulation index = 2. The modulating signal shall have a nominal frequency of 1 700 Hz and a frequency shift of  $\pm 400$  Hz with a modulation rate of 1 200 baud.

Standard test signals shall consist of a series of identical call sequences, each of which contain a known number of information symbols (format specifier, address, category, identification, etc. of ITU-R Recommendation M.493-11).

Standard test signals shall be of sufficient length for the measurements to be performed or it shall be possible to repeat them without interruption when making the measurements.

## 6.9 Determination of the symbol error ratio in the output of the receiving part

The information content of the decoded call sequence displayed at the readout device of the receiving part shall be divided into blocks, each of which corresponds to one information symbol in the applied test signal (see 6.8). The total number of incorrect information symbols relative to the total number of information symbols shall be registered. In this standard, bit error ratio measurements are taken to be equivalent to symbol error ratio measurements.

## 6.10 Measurement uncertainty and interpretation of the measured results

### 6.10.1 Measurement uncertainty

**Table 3 – Maximum values of absolute measurement uncertainties**

Radio Frequency (RF)	$\pm 1 \times 10^{-7}$
RF power/level	$\pm 0,75$ dB
Maximum frequency deviation: within 300 Hz to 6 kHz of audiofrequency within 6 kHz to 25 kHz of audiofrequency	$\pm 5$ % $\pm 3$ dB
Deviation limitation	$\pm 5$ %
Adjacent channel power	$\pm 5$ dB
Conducted spurious emission of transmitter	$\pm 4$ dB
Audio output power	$\pm 0,5$ dB
Amplitude characteristics of receiver limiter	$\pm 1,5$ dB
Sensitivity at 20 dB SINAD	$\pm 3$ dB
Conducted emission of receiver	$\pm 3$ dB
Two-signal measurement	$\pm 4$ dB
Three-signal measurement	$\pm 3$ dB
Transmitter transient time	$\pm 20$ %
Transmitter transient frequency	$\pm 250$ Hz

For the test methods according to this standard, the uncertainty figures are valid to a confidence level of 95 %.

### **6.10.2 Interpretation of the measurement results**

The interpretation of the results recorded in a test report for the measurements described in this standard shall be as follows:

- the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of this standard;
- the measurement uncertainty value for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 3.

## **6.11 Test conditions, power sources, and ambient temperatures**

### **6.11.1 Normal and extreme test conditions**

Conformance tests shall be made under normal test conditions and also, where stated, under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

### **6.11.2 Test power source**

During conformance testing, the equipment shall be supplied from a test power source capable of producing normal and extreme test voltages as specified in 6.12.2 and 6.13.2.

The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of testing, the power source voltage shall be measured at the input terminals of the equipment.

During testing, the power source voltages shall be maintained within a tolerance of  $\pm 3$  % relative to the voltage level at the beginning of each test.

## **6.12 Normal test conditions**

### **6.12.1 Normal temperature and humidity**

The normal temperature and humidity conditions for tests shall be a combination of temperature and humidity within the following ranges:

- temperature: +15 °C to +35 °C;
- relative humidity: 20 % to 75 %.

Where the relative humidity is less than 20 %, it shall be stated in the test report.

### **6.12.2 Normal power sources**

#### **6.12.2.1 Battery power source**

Where the equipment is designed to operate from a battery, the normal test voltage shall be the nominal voltage of the battery (12 V, 24 V, etc.).

#### **6.12.2.2 Other power sources**

For operation from other power sources, the normal test voltage shall be that declared by the manufacturer.

### **6.13 Extreme test conditions**

Unless otherwise stated, the extreme test conditions means that the EUT shall be tested at the upper temperature and at the upper limit of the supply voltage applied simultaneously, and at the lower temperature and the lower limit of the supply voltage applied simultaneously.

#### **6.13.1 Extreme temperatures**

For tests at extreme temperatures, measurements shall be made in accordance with 6.14, at a lower temperature of  $-15\text{ }^{\circ}\text{C}$  and an upper temperature of  $+55\text{ }^{\circ}\text{C}$ .

#### **6.13.2 Extreme values of test power sources**

##### **6.13.2.1 Battery power source**

Where the equipment is designed to operate from a battery, the extreme test voltages shall be 1,3 times and 0,9 times the nominal voltage of the battery (12 V, 24 V, etc.).

##### **6.13.2.2 Other power sources**

For operation from other sources, the extreme test voltages shall be advised by the equipment manufacturer.

### **6.14 Procedure for tests at extreme temperatures**

The equipment shall be switched off during the temperature stabilizing periods.

Before conducting tests at the upper temperature, the equipment shall be placed in the test chamber and left until thermal equilibrium is reached. The equipment shall then be switched on in the high power transmit condition for the period permitted by the push-to-talk switch in 4.4. The equipment shall meet the requirements of this standard after this period.

For tests at the lower temperature, the equipment shall be left in the test chamber until thermal equilibrium is reached and shall then be switched to the standby or receive position for 1 min, after which the equipment shall meet the requirements of this standard.

## **7 Environmental tests**

### **7.1 Introduction**

Environmental tests shall be carried out before tests are performed on the same equipment with respect to the other requirements of this standard.

### **7.2 Procedure**

Unless otherwise stated, the EUT shall be connected to an electrical power source during the periods for which it is specified that electrical tests shall be carried out. These tests shall be performed using the normal test voltage (see 6.12.2).

### **7.3 Performance check**

Where the term “performance check” is used, this shall be taken to mean a visual inspection of the equipment, a test of the transmitter output power and frequency error, and the receiver sensitivity to show that the equipment is functioning and that there is no visible damage or deterioration.

#### **a) For the transmitter:**

The transmitter shall be connected to the artificial antenna (see 6.4) and tuned to channel 16. The measurements shall be made in the absence of modulation with the

power switch set at maximum. The output power shall be between 6 W and 25 W, and the frequency error shall be less than  $\pm 1,5$  kHz.

b) For the radiotelephone receiver:

A test signal (see 6.3) with a level of +12 dB $\mu$ V shall be applied to the receiver input as in 9.3.2. The SINAD ratio at the receiver output shall be equal to or greater than 20 dB.

c) For the DSC receiver:

A standard DSC test signal (see 6.8) with a level of +6 dB $\mu$ V shall be applied to the receiver input. The symbol error ratio in the decoder output shall be equal to or less than  $10^{-2}$ .

## 7.4 Vibration test

The vibration test shall be performed as in IEC 60945.

## 7.5 Temperature tests

The dry heat cycle shall be performed as in IEC 60945.

The damp heat cycle shall be performed as in IEC 60945.

The low temperature cycle shall be performed as in IEC 60945.

## 8 Transmitter

All tests on the transmitter shall be carried out with the output power switch set at its maximum except where otherwise stated.

### 8.1 Frequency error

#### 8.1.1 Definition

The frequency error is the difference between the measured carrier frequency and its nominal value.

#### 8.1.2 Method of measurement

The carrier frequency shall be measured in the absence of modulation, with the transmitter connected to an artificial antenna (see 6.4) and tuned to channel 16.

Measurements shall be made under normal test conditions (see 6.12) and under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

This test shall be carried out with the output power switch being set at both maximum and minimum.

#### 8.1.3 Limits

The frequency error shall be within  $\pm 1,5$  kHz.

### 8.2 Carrier power

#### 8.2.1 Definition

The carrier power is the mean power delivered to the artificial antenna during one radio frequency cycle in the absence of modulation.

The rated output power is the carrier power declared by the manufacturer.

### **8.2.2 Method of measurement**

The transmitter shall be connected to an artificial antenna (see 6.4) and the power delivered to this artificial antenna shall be measured. The measurements shall be made on channel 16, the highest frequency channel and the lowest frequency channel under normal test conditions (see 6.12) and channel 16 under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

During the test on channel 16, a check should be made that the power output falls to zero after 5 min and before 6 min of continuous transmission.

### **8.2.3 Limits**

#### **8.2.3.1 Normal test conditions**

With the output power switch set at maximum, the carrier power shall remain between 6 W and 25 W and be within  $\pm 1,5$  dB of the rated output power under normal test conditions. The output power shall never, however, exceed 25 W.

With the output power switch set at minimum, the carrier power shall remain between 0,1 W and 1 W.

#### **8.2.3.2 Extreme test conditions**

With the output power switch set at maximum, the carrier power shall remain between 6 W and 25 W and be within +2 dB, -3 dB of the rated output power under extreme conditions. The output power shall never however exceed 25 W.

With the output power switch set at minimum, the carrier power shall remain between 0,1 W and 1 W.

## **8.3 Frequency deviation**

### **8.3.1 Definition**

For the purposes of this standard, the frequency deviation is the difference between the instantaneous frequency of the modulated radio frequency signal and the carrier frequency.

### **8.3.2 Maximum permissible frequency deviation**

#### **8.3.2.1 Method of measurement**

The frequency deviation shall be measured at the output with the transmitter connected to an artificial antenna (see 6.4) and tuned to channel 16, by means of a deviation meter capable of measuring the maximum deviation, including that due to any harmonics and intermodulation products which may be generated in the transmitter.

The modulation frequency shall be varied between 100 Hz and 3 kHz. The level of this test signal shall be 20 dB above the level which produces normal test modulation (see 6.3). This test shall be carried out with the output power switch set at both maximum and minimum.

#### **8.3.2.2 Limits**

The maximum frequency deviation shall be  $\pm 5$  kHz.



### **8.3.3 Reduction of frequency deviation at modulation frequencies above 3 kHz**

#### **8.3.3.1 Method of measurement**

The transmitter shall operate under normal test conditions (see 6.12) connected to a load as specified in 6.4.

The transmitter shall be modulated by the normal test modulation (see 6.3) and tuned to channel 16. With the input level of the modulation signal being kept constant, the modulation frequency shall be varied between 3 kHz and 25 kHz and the frequency deviation shall be measured.

#### **8.3.3.2 Limits**

For modulation frequencies between 3 kHz and 6 kHz the frequency deviation shall not exceed the frequency deviation with a modulation frequency of 3 kHz. For a modulation frequency of 6 kHz, the frequency deviation shall not exceed  $\pm 1,5$  kHz, as shown in Figure 1.

For modulation frequencies between 6 kHz and 25 kHz, the frequency deviation shall not exceed that given by a linear response of frequency deviation (in dB) against modulation frequency, starting at the point where the modulation frequency is 6 kHz and the frequency deviation is  $\pm 1,5$  kHz and inclined at 14 dB/octave, with the frequency deviation diminishing as the modulation frequency increases, as shown in Figure 1 as far as practicable.

### **8.4 Sensitivity of the modulator, including microphone**

#### **8.4.1 Definition**

This characteristic expresses the capability of the transmitter to produce sufficient modulation when an audiofrequency signal corresponding to the normal mean speech level is applied to the microphone.

#### **8.4.2 Method of measurement**

An acoustic signal with a frequency of 1 kHz and a sound level of 94 dB(A) shall be applied to the microphone. The resulting deviation shall be measured.

#### **8.4.3 Limits**

The resulting frequency deviation shall be between  $\pm 1,5$  kHz and  $\pm 3,5$  kHz.

### **8.5 Audiofrequency response**

#### **8.5.1 Definition**

The audiofrequency response is the frequency deviation of the transmitter as a function of the modulating frequency.

#### **8.5.2 Method of measurement**

A modulating signal at a frequency of 1 kHz shall be applied to the transmitter and the deviation shall be measured at the output. The audio input level shall be adjusted so that the frequency deviation is  $\pm 1$  kHz. This is the reference point in Figure 2 (1 kHz corresponds to 0 dB).

The modulation frequency shall then be varied between 300 Hz and 3 kHz, with the level of the audiofrequency signal being kept constant and equal to the value specified above.

### 8.5.3 Limit

The audiofrequency response shall be within +1 dB and –3 dB of a 6 dB/octave line passing through the reference point (see Figure 2).

## 8.6 Audiofrequency harmonic distortion of the emission

### 8.6.1 Definition

The harmonic distortion of the emission modulated by any audiofrequency signal is defined as the ratio, expressed as a percentage, of the root mean square (r.m.s.) voltage of all the harmonic components of the fundamental frequency to the total r.m.s. voltage of the signal after linear demodulation.

### 8.6.2 Method of measurement

The RF signal produced by the transmitter shall be applied via an appropriate coupling device to a linear demodulator with a de-emphasis network of 6 dB/octave. This test shall be carried out with the output power switch at both maximum and minimum.

#### 8.6.2.1 Normal test conditions

Under normal test conditions (see 6.12), the RF signal shall be modulated successively at frequencies of 300 Hz, 500 Hz and 1 kHz with a constant modulation index of 3.

The distortion of the audiofrequency signal shall be measured at all the frequencies specified above.

### 8.6.3 Limits

The harmonic distortion shall not exceed 10 %.

## 8.7 Adjacent channel power

### 8.7.1 Definition

The adjacent channel power is that part of the total power output of a transmitter under defined conditions of modulation which falls within a specified passband centred on the nominal frequency of either of the adjacent channels. This power is the sum of the mean power produced by the modulation hum and noise of the transmitter.

### 8.7.2 Method of measurement

The adjacent channel power can be measured with a power measuring receiver which conforms to annex B (referred to in 8.7.2 and annex B as the “receiver”) ITU-R Recommendation SM.332-4:

- a) the transmitter shall be operated with the output power switch at maximum under normal test conditions. The output of the transmitter shall be linked to the input of the “receiver” by a connecting device such that the impedance presented to the transmitter is 50  $\Omega$  and the level at the “receiver” input is appropriate;
- b) with the transmitter unmodulated, the tuning of the “receiver” shall be adjusted so that a maximum response is obtained. This is the 0 dB response point. The “receiver” attenuator setting and the reading of the meter shall be recorded;
- c) the tuning of the “receiver” shall be adjusted away from the carrier so that the “receiver” – 6 dB response nearest to the transmitter carrier frequency is located at a displacement from the nominal carrier frequency of 17 kHz;
- d) the transmitter shall be modulated with 1,25 kHz at a level which is 20 dB higher than that required to produce  $\pm 3$  kHz deviation;

- e) the “receiver” variable attenuator shall be adjusted to obtain the same meter reading as in step b) or a known relation to it;
- f) the ratio of adjacent channel power to carrier power is the difference between the attenuator settings in steps b) and e), corrected for any differences in the reading of the meter;
- g) the measurement shall be repeated with the “receiver” tuned to the other side of the carrier.

The measurement may be made with the transmitter modulated with normal test modulation, in which case this fact shall be recorded with the test results.

### 8.7.3 Limits

The adjacent channel power shall not exceed a value of 70 dB below the carrier power of the transmitter without any need to be below 0,2  $\mu$ W.

## 8.8 Conducted spurious emissions conveyed to the antenna

### 8.8.1 Definition

Conducted spurious emissions are emissions on a frequency or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions.

### 8.8.2 Method of measurement

Conducted spurious emissions shall be measured with the unmodulated transmitter connected to the artificial antenna (see 6.4).

The measurements shall be made over a range from 9 kHz to 2 GHz, excluding the channel on which the transmitter is operating and its adjacent channels.

The measurements for each spurious emission shall be made using a tuned radio measuring instrument or a spectrum analyzer.

### 8.8.3 Limit

The power of any conducted spurious emission on any discrete frequency shall not exceed 0,25  $\mu$ W.

## 8.9 Transient frequency behaviour of the transmitter

### 8.9.1 Definitions

The transient frequency behaviour of the transmitter is the variation in time of the transmitter frequency difference from the nominal frequency of the transmitter when the RF output power is switched on and off (see Figure 4).

- $t_{on}$  according to the method of measurement described in 8.10.2 the switch-on instant  $t_{on}$  of a transmitter is defined by the condition when the output power, measured at the antenna terminal, exceeds 0,1 % of the nominal power;
- $t_1$  period of time starting at  $t_{on}$  and finishing according to table 4;
- $t_2$  period of time starting at the end of  $t_1$  and finishing according to table 4;
- $t_{off}$  switch-off instant defined by the condition when the nominal power falls below 0,1 % of the nominal power;
- $t_3$  period of time that finishing at  $t_{off}$  and starting according to table 4.

**Table 4 – Transmitter transient timing (ms)**

$t_1$	5,0
$t_2$	20,0
$t_3$	5,0

NOTE 1 During the periods  $t_1$  and  $t_3$  the frequency difference should not exceed the value of 1 channel separation.

NOTE 2 During the period  $t_2$  the frequency difference should not exceed the value of half a channel separation.

### 8.9.2 Method of measurement

Two signals shall be connected to the test discriminator via a combining network (see 6.1).

The transmitter shall be connected to a 50  $\Omega$  power attenuator.

A test signal generator shall be connected to the second input of the combining network.

The test signal shall be adjusted to the nominal frequency of the transmitter.

The test signal shall be modulated by a frequency of 1 kHz with a deviation of  $\pm 25$  kHz.

The test signal level shall be adjusted to correspond to 0,1 % of the power of the transmitter under test measured at the input of the test discriminator. This level shall be maintained throughout the measurement.

The amplitude difference (ad) and the frequency difference (fd) (see Figure 3) output of the test discriminator shall be connected to a storage oscilloscope.

The storage oscilloscope shall be set to display the channel corresponding to the (fd) input up to  $\pm 25$  kHz.

The storage oscilloscope shall be set to a sweep rate of 10 ms/division and set so that the triggering occurs at one division from the left edge of the display.

The display shall show the 1 kHz test signal continuously.

The storage oscilloscope shall then be set to trigger on the channel corresponding to the amplitude difference (ad) input at a low input level, rising.

The transmitter shall then be switched on, without modulation, to produce the trigger pulse and a picture on the display.

The result of the change in the ratio of power between the test signal and the transmitter output will, due to the capture ratio of the test discriminator, produce two separate sides on the picture, one showing the 1 kHz test signal, the other the frequency difference of the transmitter versus time.

The moment when the 1 kHz test signal is completely suppressed is considered to provide  $t_{on}$ .

The periods of time  $t_1$  and  $t_2$  as defined in table 4 shall be used to define the appropriate template.

The result shall be recorded as frequency difference versus time.

The transmitter shall remain switched on.

The storage oscilloscope shall be set to trigger on the channel corresponding to the amplitude difference (ad) input at a high input level, decaying and set so that the triggering occurs at 1 division from the right edge of the display.

The transmitter shall then be switched off.

The moment when the 1 kHz test signal starts to rise is considered to provide  $t_{\text{off}}$ .

The period of time  $t_3$  as defined in table 4 shall be used to define the appropriate template.

The result shall be recorded as frequency difference versus time.

### 8.9.3 Limits

During the periods of time  $t_1$  and  $t_3$  the frequency difference shall not exceed  $\pm 25$  kHz.

The frequency difference after the end of  $t_2$  shall be within the limit of the frequency error given in 8.1.

During the period of time  $t_2$  the frequency difference shall not exceed  $\pm 12,5$  kHz.

Before the start of  $t_3$  the frequency difference shall be within the limit of the frequency error given in 8.1.

## 8.10 Residual modulation of the transmitter

### 8.10.1 Definition

The residual modulation of the transmitter is the ratio, in dB, of the demodulated RF signal in the absence of wanted modulation, to the demodulated RF signal produced when the normal test modulation is applied.

### 8.10.2 Method of measurement

The normal test modulation defined in 6.3 shall be applied to the transmitter. The high frequency signal produced by the transmitter shall be applied, via an appropriate coupling device, to a linear demodulator with a de-emphasis network of 6 dB/octave. The time constant of this de-emphasis network shall be at least 750  $\mu\text{s}$ .

Precautions shall be taken to avoid the effects of emphasizing the low audiofrequencies produced by internal noise.

The signal shall be measured at the demodulator output using an r.m.s. voltmeter.

The modulation shall then be switched off and the level of the residual audiofrequency signal at the output shall be measured again.

### 8.10.3 Limit

The residual modulation shall not exceed  $-40$  dB.

## **8.11 Frequency error (DSC signal)**

### **8.11.1 Definition**

The frequency error for the B-state and the Y-state is the difference between the measured frequency from the demodulator and the nominal values.

### **8.11.2 Method of measurement**

The transmitter shall be connected to the artificial antenna as specified in 6.4 and a suitable FM demodulator. The transmitter shall be set to channel 70.

The transmitter shall be set to transmit a continuous B-state or Y-state.

The measurement shall be performed by measuring the demodulated output, for both the continuous B-state and Y-state.

The measurements shall be carried out under normal test conditions (see 6.12) and extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

### **8.11.3 Limits**

The measured frequency from the demodulator at any time for the B-state shall be within  $2\,100\text{ Hz} \pm 10\text{ Hz}$  and for the Y-state within  $1\,300\text{ Hz} \pm 10\text{ Hz}$ .

## **8.12 Modulation index for DSC**

### **8.12.1 Definition**

This test measures the modulation index in the B and Y states.

### **8.12.2 Method of measurement**

The transmitter shall be set to transmit continuous B and then Y signals. The frequency deviations shall be measured.

### **8.12.3 Limits**

The modulation index shall be  $2,0 \pm 10\%$ .

## **8.13 Modulation rate for DSC**

### **8.13.1 Definition**

The modulation rate is the bit stream speed measured in bits per second.

### **8.13.2 Method of measurement**

The transmitter shall be set to transmit continuous dot pattern.

The RF output terminal of the transmitter, via a suitable attenuator, shall be connected to a linear FM demodulator. The output of the demodulator shall be limited in bandwidth by a low pass filter with a cut-off frequency of 1 kHz and a slope of 12 dB/octave.

The frequency of the output shall be measured.

### **8.13.3 Limits**

The frequency shall be  $600\text{ Hz} \pm 30 \times 10^{-6}$  corresponding to a modulation rate of 1 200 baud.

## **8.14 Testing of generated call sequences**

### **8.14.1 Definition**

Generated call sequences are calls which comply with the requirements of ITU-R Recommendation M.493-11.

### **8.14.2 Method of measurement**

The output of the transmitter shall be suitably connected to an apparatus for decoding and printing out the information content of the call sequences generated by the equipment.

The transmitter shall be set to transmit DSC calls as specified in annex A. For the case of the Individual routine call the following channels shall be used: 1, 1(single frequency-ship station transmit frequency), 1(single frequency-coast station transmit frequency), and 72.

### **8.14.3 Requirement**

The requirements of ITU-R Recommendation M.493-11 regarding message composition and content shall be met.

The generated calls shall be analyzed with the calibrated apparatus for correct configuration of the signal format, including time diversity. The coding for the channel information shall comply with table 1.

It shall be verified that, after transmission of a DSC call, the transmitter re-tunes to the original channel. However, in the case of a distress call, the transmitter shall tune to channel 16 and automatically select the maximum power.

The telecommands used and the channels tested for switching shall be stated in the test report.

## **9 Radiotelephone receiver**

### **9.1 Harmonic distortion and rated audiofrequency output power**

#### **9.1.1 Definition**

The harmonic distortion at the receiver output is defined as the ratio, expressed as a percentage, of the total r.m.s. voltage of all the harmonic components of the modulation audiofrequency to the total r.m.s. voltage of the signal delivered by the receiver.

The rated audiofrequency output power is the value stated by the manufacturer to be the maximum power available at the output, for which all the requirements of this standard are met.

#### **9.1.2 Methods of measurement**

Test signals at levels of +60 dB $\mu$ V (e.m.f.) and +100 dB $\mu$ V (e.m.f.), at a carrier frequency equal to the nominal frequency of the receiver and modulated by the normal test modulation (see 6.3) shall be applied in succession to the receiver input under the conditions specified in 6.1.

For each measurement, the receiver's audiofrequency volume control shall be set so as to obtain, in a resistive load which simulates the receiver's operating load, the rated audiofrequency output power (see 9.1.1). The value of this load shall be stated by the manufacturer.

Under normal test conditions (see 6.12) the test signal shall be modulated successively at 300 Hz, 500 Hz and 1 kHz with a constant modulation index of 3 (ratio between the frequency deviation and the modulation frequency). The harmonic distortion and audiofrequency output power shall be measured at all the frequencies specified above.

### **9.1.3 Limits**

The rated audiofrequency output power shall be at least:

- 2 W in a loudspeaker;
- 1 mW in the handset earphone.

The harmonic distortion shall not exceed 10 %.

## **9.2 Audiofrequency response**

### **9.2.1 Definition**

The audiofrequency response is defined as the variation in the receiver's audiofrequency output level as a function of the modulation frequency of the radio frequency signal with constant deviation applied to its input.

### **9.2.2 Method of measurement**

A test signal of +60 dB $\mu$ V (e.m.f.), at a carrier frequency equal to the nominal frequency of the receiver and modulated with normal test modulation (see 6.3) shall be applied to the receiver antenna port under the conditions specified in 6.1.

The receiver's audiofrequency power control shall be set so as to produce a power level equal to 50 % of the rated output power (see 9.1). This setting shall remain unchanged during the test.

The frequency deviation shall then be reduced to  $\pm 1$  kHz and the audio output is the reference point in Figure 5 (1 kHz corresponds to 0 dB).

The frequency deviation shall remain constant while the modulation frequency is varied between 300 Hz and 3 kHz and the output level shall then be measured.

The measurement shall be repeated with a test signal at frequencies 1,5 kHz above and below the nominal frequency of the receiver.

### **9.2.3 Limits**

The audiofrequency response shall not deviate by more than +1 dB or –3 dB from a characteristic giving the output level as a function of the audiofrequency, decreasing by 6 dB/octave and passing through the measured point at 1 kHz (see Figure 5).

## **9.3 Maximum usable sensitivity**

### **9.3.1 Definition**

The maximum usable sensitivity of the receiver is the minimum level of the signal (e.m.f.) at the nominal frequency of the receiver which, when applied to the receiver input with normal test modulation (see 6.3), will produce:

- in all cases, an audiofrequency output power equal to 50 % of the rated output power (see 9.1); and



- a Signal + Noise + Distortion to Noise + Distortion (SINAD) ratio of 20 dB, measured at the receiver output through a psophometric telephone filtering network such as described in ITU-T Recommendation O.41.

### **9.3.2 Method of measurement**

A test signal at a carrier frequency equal to the nominal frequency of the receiver, modulated by the normal test modulation (see 6.3) shall be applied to the receiver input. An audiofrequency load and a measuring instrument for measuring SINAD ratio (through a psophometric network as specified in 9.3.1) shall be connected to the receiver output terminals.

The level of the test signal shall be adjusted until a SINAD ratio of 20 dB is obtained, using the psophometric network and with the receiver's audiofrequency power control adjusted to produce 50 % of the rated output power. Under these conditions, the level of the test signal at the input is the value of the maximum usable sensitivity.

The measurements shall be made under normal test conditions (see 6.12) and under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

A receiver output power variation of  $\pm 3$  dB relative to 50 % of the rated output power may be allowed for sensitivity measurements under extreme test conditions.

### **9.3.3 Limits**

The maximum usable sensitivity shall not exceed +6 dB $\mu$ V (e.m.f.) under normal test conditions and +12 dB $\mu$ V (e.m.f.) under extreme test conditions.

## **9.4 Co-channel rejection**

### **9.4.1 Definition**

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

### **9.4.2 Method of measurement**

The two input signals shall be connected to the receiver via a combining network (see 6.1). The wanted signal shall have normal test modulation (see 6.3). The unwanted signal shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz. Both input signals shall be at the nominal frequency of the receiver under test and the measurement repeated for displacements of the unwanted signal of  $\pm 3$  kHz.

The wanted input signal shall be set to the value corresponding to the measured maximum usable sensitivity (see 9.3).

The amplitude of the unwanted input signal shall then be adjusted until the SINAD ratio (psophometrically weighted) at the output of the receiver is reduced to 14 dB.

The co-channel rejection ratio shall be expressed as the ratio in dB of the level of the unwanted signal to the level of the wanted signal at the receiver input for which the specified reduction in SINAD ratio occurs.

### **9.4.3 Limit**

The co-channel rejection ratio shall be between  $-10$  dB and 0 dB.

## **9.5 Adjacent channel selectivity**

### **9.5.1 Definition**

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by 25 kHz.

### **9.5.2 Method of measurement**

The two input signals shall be applied to the receiver input via a combining network (see 6.1). The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (see 6.3). The unwanted signal shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz, and shall be at the frequency of the channel immediately above that of the wanted signal.

The wanted input signal level shall be set to the value corresponding to the maximum usable sensitivity. The amplitude of the unwanted input signal shall then be adjusted until the SINAD ratio at the receiver output, psophometrically weighted, is reduced to 14 dB. The measurement shall be repeated with an unwanted signal at the frequency of the channel below that of the wanted signal.

The adjacent channel selectivity shall be expressed as the lower value of the ratios in dB for the upper and lower adjacent channels of the level of the unwanted signal to the level of the wanted signal.

The measurements shall then be repeated under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously) with the wanted signal set to the value corresponding to the maximum usable sensitivity under these conditions.

### **9.5.3 Limits**

The adjacent channel selectivity shall be not less than 70 dB under normal test conditions and not less than 60 dB under extreme test conditions.

## **9.6 Spurious response rejection**

### **9.6.1 Definition**

The spurious response rejection is a measure of the capability of the receiver to discriminate between the wanted modulated signal at the nominal frequency and an unwanted signal at any other frequency at which a response is obtained.

### **9.6.2 Method of measurement**

Two input signals shall be applied to the receiver input via a combining network (see 6.1). The wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (see 6.3).

The unwanted signal shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz.

The wanted input signal level shall be set to the value corresponding to the maximum usable sensitivity. The amplitude of the unwanted input signal shall be adjusted to an e.m.f. of +86 dB $\mu$ V. The frequency shall then be swept over the frequency range from 100 kHz to 2 000 MHz.

At any frequency at which a response is obtained, the input level shall be adjusted until the SINAD ratio psophometrically weighted, is reduced to 14 dB.

The spurious response rejection ratio shall be expressed as the ratio in dB between the unwanted signal and the wanted signal at the receiver input when the specified reduction in the SINAD ratio is obtained.

### **9.6.3 Limit**

At any frequency separated from the nominal frequency of the receiver by more than 25 kHz, the spurious response rejection ratio shall be not less than 70 dB.

## **9.7 Intermodulation response**

### **9.7.1 Definition**

The intermodulation response is a measure of the capability of a receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

### **9.7.2 Method of measurement**

Three signal generators, A, B and C shall be connected to the receiver via a combining network (see 6.1). The wanted signal, represented by signal generator A shall be at the nominal frequency of the receiver and shall have normal test modulation (see 6.3). The unwanted signal from signal generator B shall be unmodulated and adjusted to the frequency 50 kHz above (or below) the nominal frequency of the receiver. The second unwanted signal from signal generator C shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz, and adjusted to a frequency 100 kHz above (or below) the nominal frequency of the receiver.

The wanted input signal shall be set to a value corresponding to the maximum usable sensitivity. The amplitude of the two unwanted signals shall be maintained equal and shall be adjusted until the SINAD ratio at the receiver output, psophometrically weighted, is reduced to 14 dB. The frequency of signal generator B shall be adjusted slightly to produce the maximum degradation of the SINAD ratio. The level of the two unwanted test signals shall be readjusted to restore the SINAD ratio of 14 dB. The intermodulation response ratio shall be expressed as the ratio in dB between the two unwanted signals and the wanted signal at the receiver input, when the specified reduction in the SINAD ratio is obtained.

### **9.7.3 Limit**

The intermodulation response ratio shall be greater than 68 dB.

## **9.8 Blocking or desensitization**

### **9.8.1 Definition**

Blocking is a change (generally a reduction) in the wanted output power of the receiver or a reduction of the SINAD ratio due to an unwanted signal on another frequency.

### **9.8.2 Method of measurement**

Two input signals shall be applied to the receiver via a combining network (see 6.1). The modulated wanted signal shall be at the nominal frequency of the receiver and shall have normal test modulation (see 6.3). Initially, the unwanted signal shall be switched off and the wanted signal set to the value corresponding to the maximum usable sensitivity.

The output power of the wanted signal shall be adjusted, where possible, to 50 % of the rated output power and in the case of stepped volume controls, to the first step that provides an output power of at least 50 % of the rated output power. The unwanted signal shall be unmodulated and the frequency shall be swept between +1 MHz and +10 MHz, and also between -1 MHz and -10 MHz, relative to the nominal frequency of the receiver. The input

level of the unwanted signal, at all frequencies in the specified ranges, shall be so adjusted that the unwanted signal causes:

- a) a reduction of 3 dB in the output level of the wanted signal; or
- b) a reduction to 14 dB of the SINAD ratio at the receiver output using a psophometric telephone filtering network such as described in ITU-T Recommendation O.41 whichever occurs first. This level shall be noted.

### **9.8.3 Limit**

The blocking level for any frequency within the specified ranges, shall be not less than 90 dB $\mu$ V (e.m.f.), except at frequencies on which spurious responses are found (see 9.6).

## **9.9 Spurious emissions**

### **9.9.1 Definition**

Spurious emissions from the receiver are components at any frequency, present at the receiver input port.

The level of spurious emissions shall be measured as the power level at the antenna.

### **9.9.2 Method of measuring the power level**

Spurious emissions shall be measured as the power level of any discrete signal at the input terminals of the receiver. The receiver input terminals are connected to a spectrum analyzer or selective voltmeter having an input impedance of 50  $\Omega$  and the receiver is switched on.

If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by a substitution method using a signal generator.

The measurements shall extend over the frequency range of 9 kHz to 2 GHz.

### **9.9.3 Limit**

The power of any spurious emission shall not exceed 2 nW at any frequency in the range between 9 kHz and 2 GHz.

## **9.10 Receiver residual noise level**

### **9.10.1 Definition**

The receiver residual noise level is defined as the ratio, in dB, of the audiofrequency power of the noise and hum resulting from spurious effects of the power supply system or from other causes, to the audiofrequency power produced by a high-frequency signal of average level, modulated by the normal test modulation and applied to the receiver input.

### **9.10.2 Method of measurement**

A test signal with a level of +30 dB $\mu$ V (e.m.f.) at a carrier frequency equal to the nominal frequency of the receiver, and modulated by the normal test modulation specified in 6.3, shall be applied to the receiver input. An audiofrequency load shall be connected to the output terminals of the receiver. The audiofrequency power control shall be set so as to produce the rated output power level conforming to 9.1.

The output signal shall be measured by an r.m.s. voltmeter having a –6 dB bandwidth of at least 20 kHz. The modulation shall then be switched off and the audiofrequency output level measured again.

### 9.10.3 Limit

The receiver residual noise level shall not exceed  $-40$  dB.

## 9.11 Squelch operation

### 9.11.1 Definition

The purpose of the squelch facility is to mute the receiver audio output signal when the level of the signal at the receiver input is less than a given value.

### 9.11.2 Method of measurement

- a) With the squelch facility switched off, a test signal of  $+30$  dB $\mu$ V (e.m.f.), at a carrier frequency equal to the nominal frequency of the receiver and modulated by the normal test modulation specified in 6.3, shall be applied to the input terminals of the receiver. An audiofrequency load and a psophometric filtering network shall be connected to the output terminals of the receiver. The receiver's audiofrequency power control shall be set so as to produce the rated output power defined in 9.1.

The output signal shall be measured with the aid of an r.m.s. voltmeter.

The input signal shall then be suppressed, the squelch facility switched on and the audiofrequency output level measured again.

- b) With the squelch facility switched off again, a test signal modulated by the normal test modulation shall be applied to the receiver input at a level of  $+6$  dB $\mu$ V (e.m.f.) and the receiver shall be set to produce 50 % of the rated output power.

The level of the input signal shall then be reduced and the squelch facility shall be switched on.

The input signal shall then be increased until the above-mentioned output power is reached.

The SINAD ratio and the input level shall then be measured.

- c) (Applicable only to equipment with continuously adjustable squelch control.) With the squelch facility switched off, a test signal with normal test modulation shall be applied to the receiver input at a level of  $+6$  dB $\mu$ V (e.m.f.), and the receiver shall be adjusted to give 50 % of the rated audio output power.

The level of the input signal shall then be reduced and the squelch facility shall be switched on at its maximum position and the level of the input signal increased until the output power again is 50 % of the rated audio output power.

### 9.11.3 Limits

Under the conditions specified in 9.11.2 a), the audiofrequency output power shall not exceed  $-40$  dB relative to the rated output power.

Under the conditions specified in 9.11.2 b), the input level shall not exceed  $+6$  dB $\mu$ V (e.m.f.) and the SINAD ratio shall be at least 20 dB.

Under the conditions specified in 9.11.2 c), the input signal shall not exceed  $+6$  dB $\mu$ V (e.m.f.) when the control is set at maximum.

## 9.12 Squelch hysteresis

### 9.12.1 Definition

Squelch hysteresis is the difference in dB between the receiver input signal levels at which the squelch opens and closes.

### **9.12.2 Method of measurement**

If there is any squelch control on the exterior of the equipment it shall be placed in its maximum muted position. With the squelch facility switched on, an unmodulated input signal at a carrier frequency equal to the nominal frequency of the receiver shall be applied to the input of the receiver at a level sufficiently low to avoid opening the squelch. The input signal shall be increased at the level just opening the squelch. This input level shall be recorded. With the squelch still open, the level of the input signal shall be slowly decreased until the squelch mutes the receiver audio output again.

### **9.12.3 Limit**

The squelch hysteresis shall be between 3 dB and 6 dB.

## **9.13 Multiple watch characteristic**

### **9.13.1 Definition**

The scanning period is the time between the start of two successive samples of the priority channel in the absence of a signal on that channel.

The dwell time on the priority channel is the time between the start and finish of any sample of the priority channel in the absence of a signal on that channel.

The dwell time on the additional channel is the time between the start and finish of any sample of the additional channel.

### **9.13.2 Method of measurement**

The equipment shall be adjusted to scan the priority channel and one additional channel.

The squelch shall be operational and so adjusted that the receiver just mutes on both the channels.

A test signal at the carrier frequency equal to the nominal frequency of the additional channel of the receiver, modulated by the normal test modulation (see 6.3) shall be connected to the receiver via a combining network (see 6.1). A second test signal with a frequency equal to the nominal frequency of the priority channel having no modulation shall be connected to the receiver via the other input of the combining network. The level of the two test signals shall be +12 dB $\mu$ V (e.m.f.) at the receiver input.

A storage oscilloscope shall be connected to the audio output. Initially, the output of the test signal on the priority channel shall be switched off. The scanning process is started and the output observed on the oscilloscope. The gap between and the duration of the audio bursts shall be measured. Now the test signal on the priority channel shall be switched on and the scanning shall stop on the priority channel after the last burst and within the dwell time on the priority channel. The measurement shall be carried out where the additional channel is a simplex channel and repeated where it is a duplex channel.

The measurements shall be made under normal and under extreme test conditions.

### **9.13.3 Limits**

The scanning period shall not exceed 2 s.

The dwell time on the priority channel shall not exceed 150 ms.

The dwell time on the additional channel shall be between 850 ms and 2 s as indicated by the time of the gap between two output bursts.

## **10 Receiver for DSC decoder**

During all DSC decoder tests the equipment shall be set to scan the priority channel and the maximum number of additional channels available.

### **10.1 Maximum usable sensitivity**

#### **10.1.1 Definition**

The maximum usable sensitivity of the receiver is the minimum level of the signal (e.m.f.) at the nominal frequency of the receiver which when applied to the receiver input with a test modulation will produce a bit error ratio of  $10^{-2}$ .

#### **10.1.2 Method of measurement**

DSC standard test signal (see 6.8) containing DSC calls shall be applied to the receiver input. The input level shall be 0 dB $\mu$ V under normal test conditions (see 6.12) and +6 dB $\mu$ V under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

The measurement shall be repeated under normal test conditions at the nominal carrier frequency  $\pm 1,5$  kHz.

The bit error ratio in the decoder output shall be determined as described in 6.9.

#### **10.1.3 Limits**

The bit error ratio shall be equal to or less than  $10^{-2}$ .

### **10.2 Co-channel rejection**

#### **10.2.1 Definition**

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

#### **10.2.2 Method of measurement**

The two input signals shall be connected to the receiver input terminal via a combining network (see 6.1). The wanted signal shall be the DSC standard test signal (see 6.8) containing DSC calls. The level of the wanted signal shall be +3 dB $\mu$ V. The unwanted signal shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz. Both input signals shall be at the nominal frequency of the receiver under test and the measurement shall be repeated for displacements of the unwanted signal of up to  $\pm 3$  kHz.

The input level of the unwanted signal shall be  $-5$  dB $\mu$ V.

The bit error ratio in the decoder output shall be determined as described in 6.9.

#### **10.2.3 Limits**

The bit error ratio shall be equal to or less than  $10^{-2}$ .

### **10.3 Adjacent channel selectivity**

#### **10.3.1 Definition**

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by 25 kHz.

#### **10.3.2 Method of measurement**

The two input signals shall be connected to the receiver input terminal via a combining network (see 6.1).

The wanted signal shall be the DSC standard test signal (see 6.8) containing DSC calls. The level of the wanted signal shall be +3 dB $\mu$ V under normal test conditions and +9 dB $\mu$ V under extreme test conditions.

The unwanted signal shall be modulated to 400 Hz with a deviation of  $\pm 3$  kHz. The unwanted signal shall be tuned to the centre frequency of the upper adjacent channel. The input level of the unwanted signal shall be 73 dB $\mu$ V under normal test conditions and 63 dB $\mu$ V under extreme test conditions.

The bit error ratio in the decoder output shall be determined as described in 6.9.

The measurement shall be repeated with the unwanted signal tuned to the centre frequency of the lower adjacent channel.

The measurement shall be carried out under normal test conditions (see 6.12) and under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

#### **10.3.3 Limits**

The bit error ratio shall be equal to or less than  $10^{-2}$ .

### **10.4 Spurious response and blocking immunity**

#### **10.4.1 Definition**

The spurious response and blocking immunity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal with frequencies outside the pass band of the receiver.

#### **10.4.2 Method of measurement**

The two input signals shall be connected to the receiver input terminal via a combining network (see 6.1).

The wanted signal shall be the DSC standard test signal (see 6.8) containing DSC calls. The level of the wanted signal shall be +3 dB $\mu$ V.

For the spurious response test, the unwanted signal shall be unmodulated. The frequency shall be varied over the range 9 kHz to 2 GHz with the exception of the channel of the wanted signal and its adjacent channels. The unwanted signal level shall be 73 dB $\mu$ V. Where spurious response occurs, the bit error ratio shall be determined.

For the blocking test, the unwanted signal shall be unmodulated. The frequency shall be varied between  $-10$  MHz and  $-1$  MHz and also between  $+1$  MHz and  $+10$  MHz relative to the



nominal frequency of the wanted signal. The unwanted signal shall be at a level of 93 dB $\mu$ V. Where blocking occurs, the bit error ratio shall be determined.

The bit error ratio in the decoder output shall be determined as described in 6.9.

#### **10.4.3 Limits**

The bit error ratio shall be equal to or less than  $10^{-2}$ .

### **10.5 Intermodulation response**

#### **10.5.1 Definition**

The intermodulation response is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

#### **10.5.2 Method of measurement**

The three input signals shall be connected to the receiver input terminal via a combining network (see 6.1).

The wanted signal represented by signal generator A shall be at the nominal frequency of the receiver and shall be the DSC standard test signal (see 6.8) containing DSC calls. The level of the wanted signal shall be +3 dB $\mu$ V.

The unwanted signals shall be applied, both at the same level. The unwanted signal from signal generator B shall be unmodulated and adjusted to a frequency 50 kHz above (or below) the nominal frequency of the receiver. The second unwanted signal from signal generator C shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz and adjusted to a frequency 100 kHz above (or below) the nominal frequency of the receiver.

The input level of the unwanted signals shall be 68 dB $\mu$ V.

The bit error ratio in the decoder output shall be determined as described in 6.9.

#### **10.5.3 Limits**

The bit error ratio shall be equal to or less than  $10^{-2}$ .

### **10.6 Dynamic range**

#### **10.6.1 Definition**

The dynamic range of the equipment is the range from the minimum to the maximum level of a radio frequency input signal at which the bit error ratio in the output of the decoder does not exceed a specified value.

#### **10.6.2 Method of measurement**

A test signal in accordance with the DSC standard test signal (see 6.8) containing consecutive DSC calls, shall be applied to the receiver input. The level of the test signal shall alternate between 100 dB $\mu$ V and 0 dB $\mu$ V.

The bit error ratio in the decoder output shall be determined as described in 6.9.

#### **10.6.3 Limit**

The bit error ratio shall be equal to or less than  $10^{-2}$ .

## **10.7 Spurious emissions**

### **10.7.1 Definition**

Spurious emissions from the receiver are components at any frequency, present at the receiver input port.

The level of spurious emissions shall be measured as the power level at the antenna.

### **10.7.2 Method of measuring the power level**

Spurious emissions shall be measured as the power level of any discrete signal at the input terminals of the receiver. The receiver input terminals are connected to a spectrum analyzer or selective voltmeter having an input impedance of 50  $\Omega$  and the receiver is switched on.

If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by a substitution method using a signal generator.

The measurements shall extend over the frequency range of 9 kHz to 2 GHz.

### **10.7.3 Limit**

The power of any spurious emission shall not exceed 2 nW at any frequency in the range between 9 kHz and 2 GHz.

## **10.8 Verification of correct decoding of various types of DSC calls**

### **10.8.1 Definition**

DSC call sequences are calls that comply with ITU-R Recommendation M.493-11.

### **10.8.2 Method of measurement**

The input terminal of the receiver shall be suitably connected to a calibrated apparatus for generation of digital selective call signals.

DSC calls as specified in annex A shall be applied to the receiver. For the case of the Individual routine call the following channels shall be used: 1, 1(single frequency-ship station transmit frequency), 1(single frequency-coast station transmit frequency), and 72. For channel 1 the digit "M" (see table 2) shall be set to values of 0,3,4,5,6,7,8 and 9. For channel 72 the digit "M" shall be set to values of 0,1,2,3,4,5,6,7,8 and 9.

### **10.8.3 Requirement**

The requirements of ITU-R Recommendation M.493-11 regarding message composition and content shall be met.

The decoded call sequences at the output of the receiver shall be examined for correct technical format, including error-check characters.

When receiver measurements are made by use of a printer or a computer, a check shall be made to ensure accordance between printer output and display indication.

It shall be verified that the equipment is capable of switching to the channels identified in the DSC call.

The telecommands used and channels tested for switching shall be stated in the test report.

## **10.9 Reaction to VTS and AIS channel management DSC transmissions**

### **10.9.1 Definition**

VTS and AIS channel management DSC transmissions are any DSC transmissions that are in accordance with Recommendation ITU-R M.825 or M.1371.

### **10.9.2 Method of measurement**

The input terminal of the receiver shall be connected as per 10.8.2. DSC polling and regional channel management in accordance with Annex 3 of ITU-R M.1371-1 shall be applied to the receiver. A DSC transmission of format specifier symbol 112 and then with 116, category symbol 103, and otherwise similar to a distress call described in Table 4 of ITU-R M.493-11 shall also be made.

### **10.9.3 Requirement**

The equipment shall not sound an alarm, display a message (an accurate, informative display is permissible but not required), transmit a response or suggest a transmitted response, lock up, or require operator intervention.

## **10.10 Simultaneous reception**

### **10.10.1 Definition**

Simultaneous reception is the ability of the unit to correctly receive DSC traffic and radiotelephony traffic at the same time.

### **10.10.2 Method of measurement**

The radiotelephone shall be set for operation on channel 16.

Two input signals shall be connected to the receiver input terminal via combining network (see 6.1).

The radiotelephone test signal shall be at a carrier frequency equal to the nominal frequency of the receiver, modulated by the normal test modulation (see 6.3) shall be applied to the receiver input.

An audiofrequency load and a measuring instrument for measuring SINAD ratio (through a psophometric network as specified in 9.3.1) shall be connected to the receiver output terminals.

The radiotelephone test signal level shall be set for 20 dB $\mu$ V.

The SINAD shall be measured with and without the presence of the DSC test signal.

The DSC standard test signal input level shall be 0 dB $\mu$ V (see 6.8) containing DSC calls.

The bit error ratio in the decoder output shall be determined as described in 6.9.

### **10.10.3 Limits**

For radiotelephony operation the SINAD ratio shall be no less than 20 dB in the presence of the DSC test signal.

The DSC bit error ratio shall be equal to or less than  $10^{-2}$ .

## **11 Electromagnetic compatibility**

### **11.1.1 Conducted spurious emission**

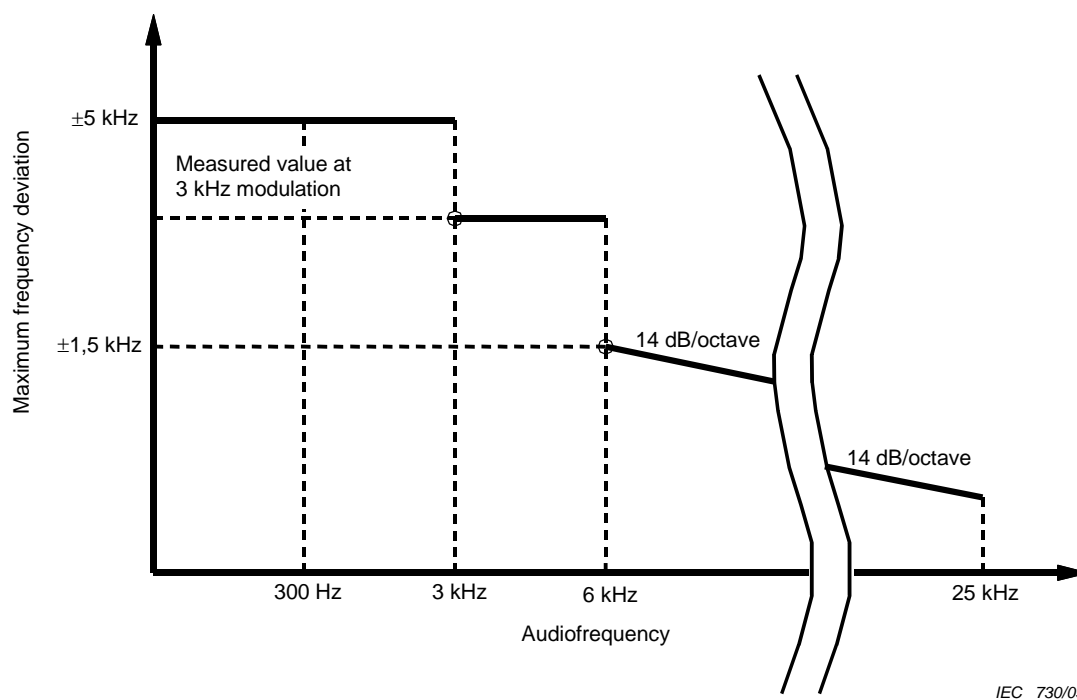
Conducted spurious emissions shall be determined as specified in IEC 60945 and comply to the limits contained therein.

### **11.1.2 Radiated spurious emission**

Radiated spurious emissions shall be determined as specified in IEC 60945 and comply to the limits contained therein.

### **11.1.3 Immunity to electromagnetic environment**

Tests for immunity to electromagnetic environment (conducted, radiated or transient) as applicable shall be performed as specified in IEC 60945.

**Figure 1 – Frequency deviation**

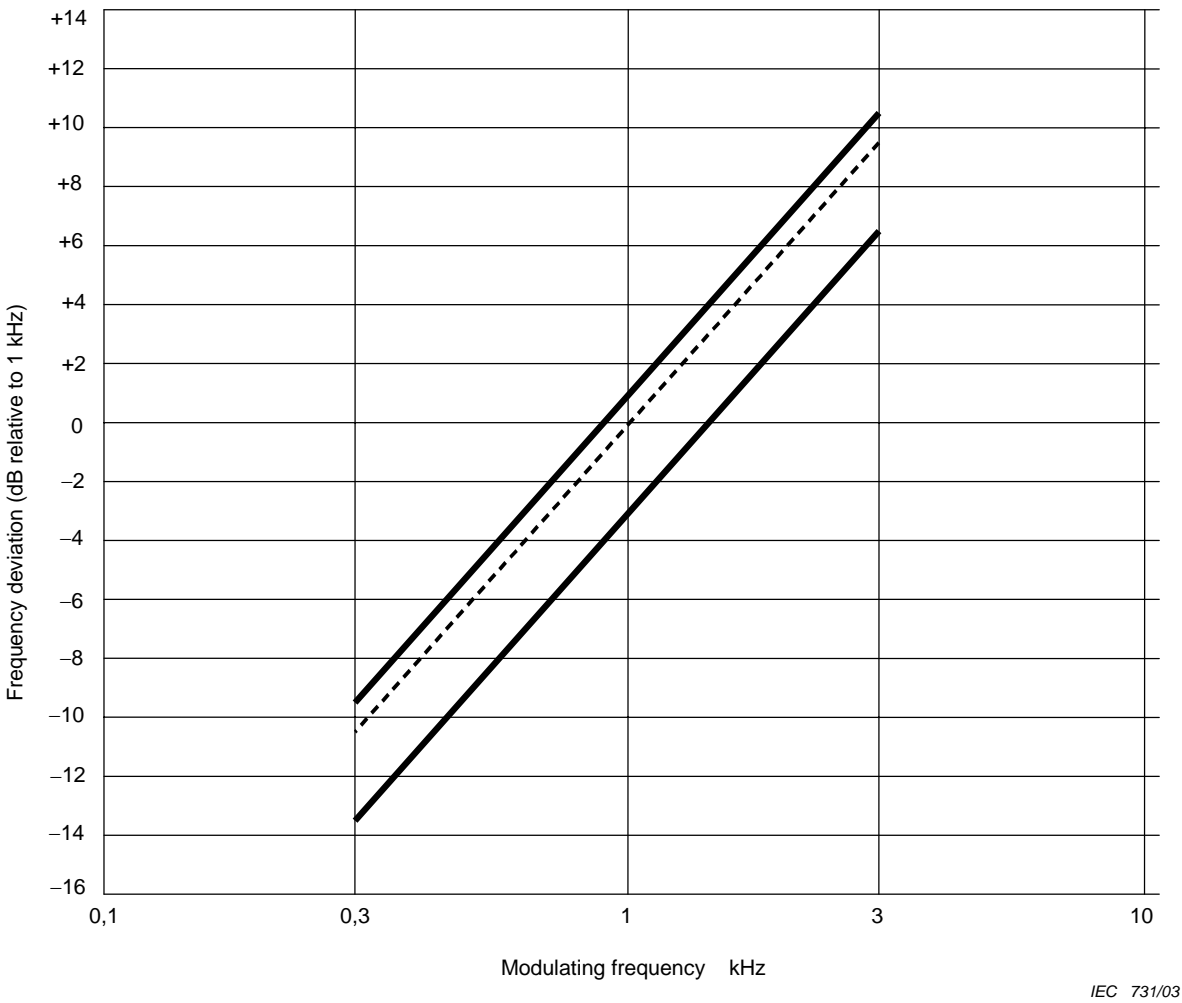
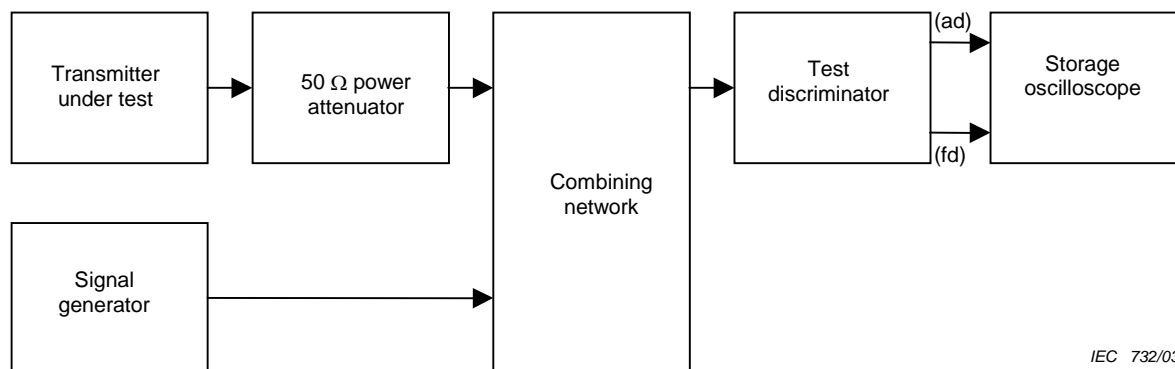
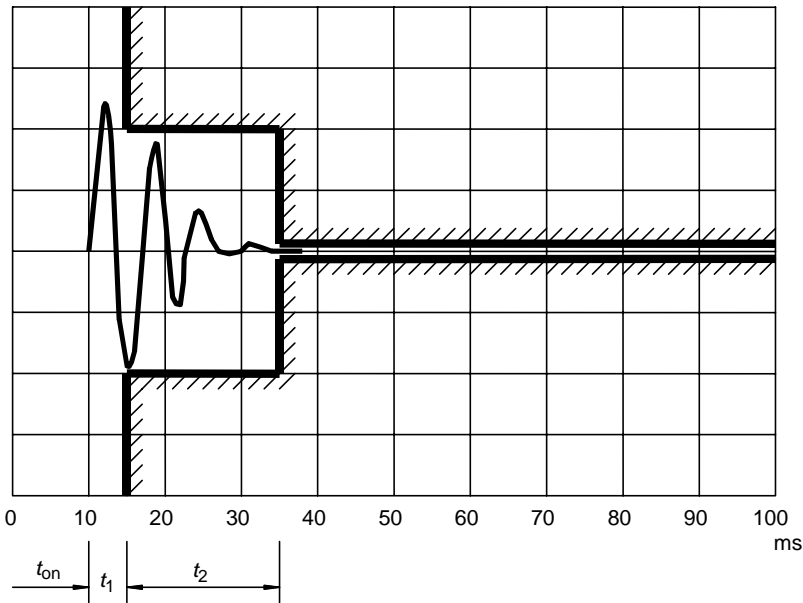


Figure 2 – Audiofrequency response



**Figure 3 – Test set-up for measuring transient frequency behaviour**

Switch-on condition  $t_{on}$ ,  $t_1$  and  $t_2$



$+\delta f = 1$  channel separation

$+\delta f = 1/2$  channel separation

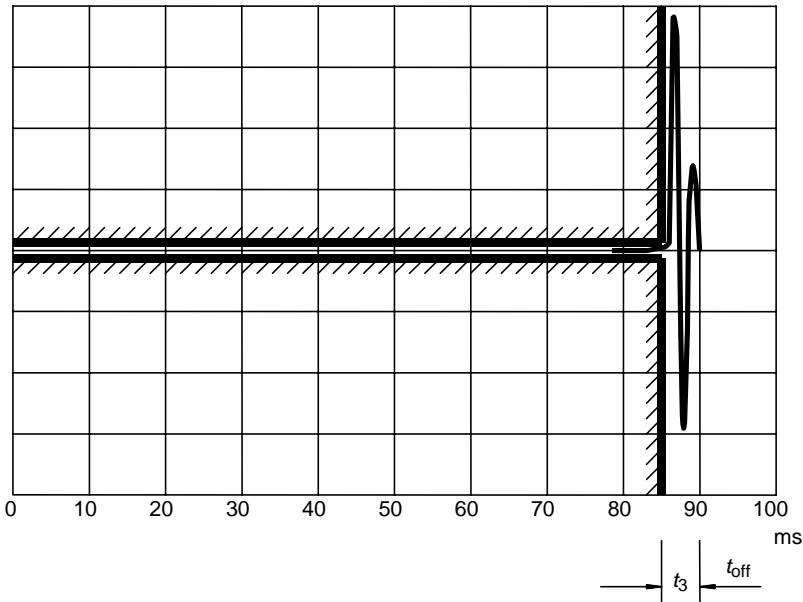
Nominal frequency

$-\delta f = 1/2$  channel separation

$-\delta f = 1$  channel separation

IEC 733/03

Switch-off condition  $t_3$ ,  $t_{off}$



$+\delta f = 1$  channel separation

$+\delta f = 1/2$  channel separation

Nominal frequency

$-\delta f = 1/2$  channel separation

$-\delta f = 1$  channel separation

IEC 734/03

Figure 4 – Storage oscilloscope view  $t_1$ ,  $t_2$  and  $t_3$



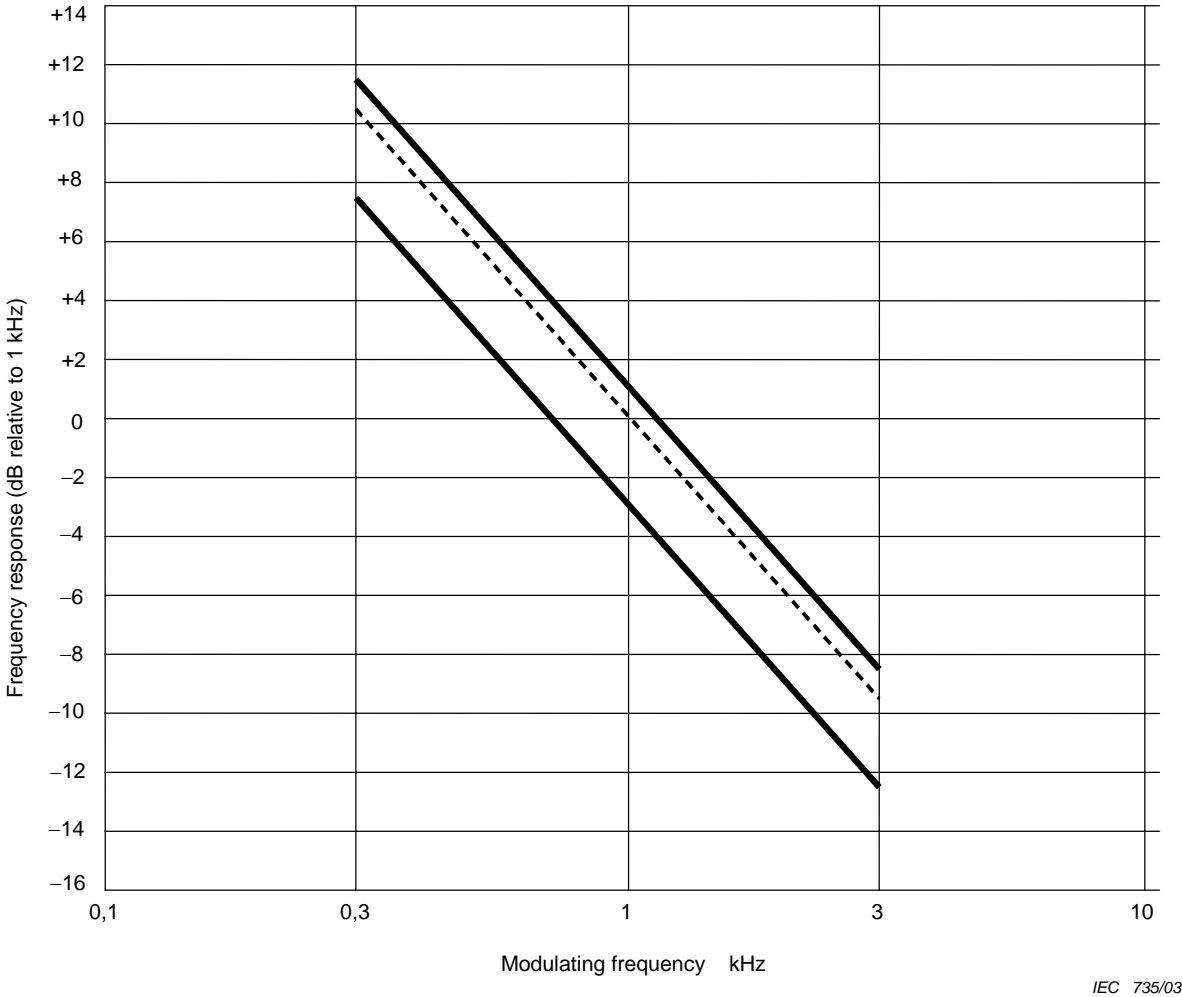


Figure 5 – Receiver audiofrequency response

## Annex A (normative)

### DSC calls

**Table A.1 – DSC calls to ITU-R Recommendation M.493**

Format specifier	Category	1st telecommand (symbol No.)	Receive	Transmit
Distress		F3E/G3E simplex (100)	X	X
All ships	Distress	Distress Ack (110)	X	
All ships	Distress	Distress Relay (112)	X	
All ships	Urgency	F3E/G3E simplex (100)	X	X
All ships	Safety	F3E/G3E simplex (100)	X	X
Individual	Urgency	F3E/G3E simplex (100)	X	
Individual	Safety	F3E/G3E simplex (100)	X	
Individual	Routine	F3E/G3E simplex (100)	X	X
Group	Routine	F3E/G3E simplex (100)	X	X
2nd telecommand Transmit and receive (126) No information				

**Table A.2 – DSC calls to ITU-R Recommendation M.821**

Expansion data specifier	Receive	Transmit
100 Enhanced position resolution	X	X

**Table A.3 – Example of transmitted DSC Distress call**

<b>Dot Pattern</b> (20 bits)	<b>DX/RX Phasing Sequence</b> (6)	<b>Format Specifier</b> (2)	<b>Self-Identification</b> (5)	<b>Message 1 Nature of Distress</b> (1)	<b>Message 2 Position</b> (5)	<b>Message 3 Position time</b> (2)	<b>Message 4 Subsequent comms</b> (1)	<b>EOS</b> (1)	<b>ECC</b> (1)	<b>EOS</b> (2)
Distress alert example (undesignated) Position 49° 05.4321N 123° 19.9876W		112 112	31 60 01 5410*  *DSC unit to automatically insert a 0 as the 10 <sup>th</sup> digit	107	14 90 51 23 19	1755	100	127	ECC	127 127
Expansion sequence (sent once after 5 repeats of above sequence)	<b>Start of sequence</b>			<b>Expansion data specifier</b>		<b>Enhanced position</b>		<b>EOS</b>	<b>ECC</b>	<b>EOS</b>
	DX characters 126 126			100		43 21 98 76		127	ECC	127 127

**Table A.4 – Examples of transmitted DSC calls**

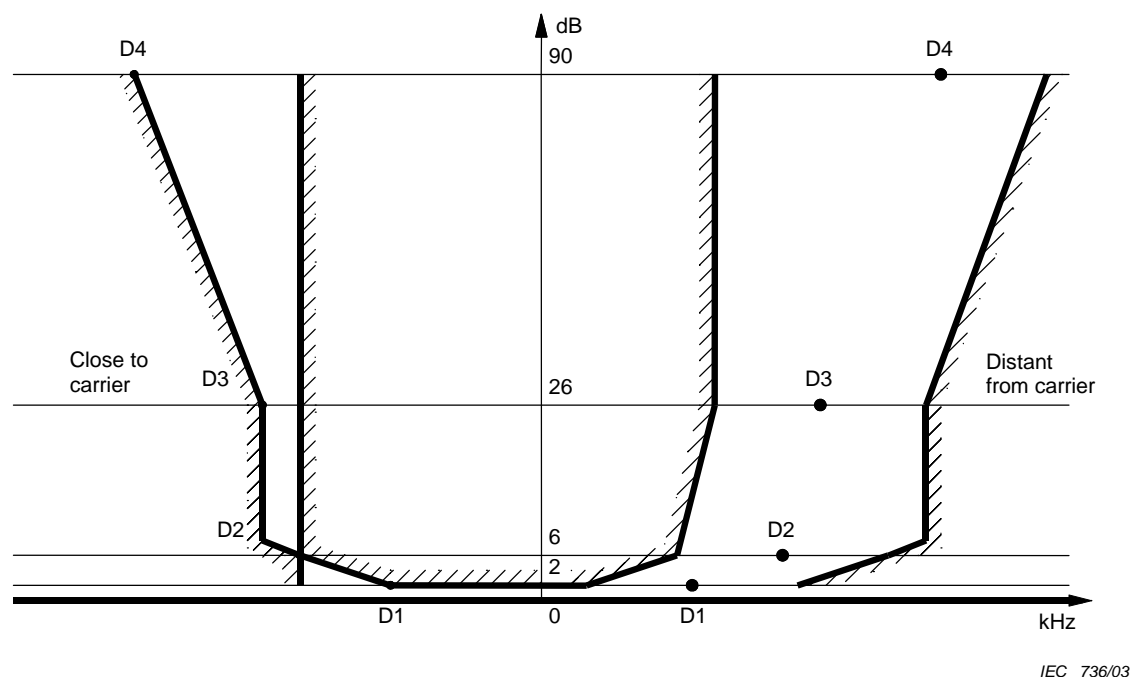
<b>Dot Pattern</b> (20 bits)	<b>DX/RX Phasing sequence</b> (6)	<b>A Format Specifier</b> (2)	<b>B Called party Address</b> (5)	<b>C Category</b> (1)	<b>D Self-Identification</b> (5)	<b>E Telecommand Message</b> (2)	<b>F Frequency Message</b> (3)	<b>G Frequency Message</b> (3)	<b>H EOS</b> (1)	<b>I ECC</b> (1)	<b>H EOS</b> (2)
Urgency call		116 116	Not used	110	31 60 01 54 10	100 126	90 00 16	126 126 126	127	ECC	127 127
Safety call		116 116	Not used	108	31 60 01 54 10	100 126	90 00 16	126 126 126	127	ECC	127 127
Routine individual call		120 120	00 31 60 01 10	100	31 60 01 54 10	126 126	90 00 72	126 126 126	117	ECC	117 117
Routine individual call to coast radio station		120 120	00 31 60 01 10	100	31 60 01 54 10	126 126	126 126 126	126 126 126	117	ECC	117 117
Group call		114 114	03 16 12 34 50	110	31 60 01 54 10	100 126	90 00 72	126 126 126	127	ECC	127 127

## Annex B (normative)

### Power measuring receiver specification

#### B.1 IF filter

The IF filter shall be within the limits specified in Figure B.1:



**Figure B.1 – IF filter specification**

The selectivity characteristics shall maintain the following frequency separations from the nominal centre frequency of the adjacent channel given in table B.1.

**Table B.1 – Selectivity characteristic**

Frequency separation of filter curve from nominal centre frequency of adjacent channel kHz			
D1	D2	D3	D4
5	8,0	9,25	13,25

The attenuation points shall not exceed the following tolerances:

**Table B.2 – Attenuation points close to carrier**

Tolerance kHz			
D1	D2	D3	D4
+3,1	±0,1	–1,35	–5,35

**Table B.3 – Attenuation points distant from carrier**

Tolerance kHz			
D1	D2	D3	D4
±3,5	±3,5	±3,5	+3,5 –7,5

The minimum attenuation of the filter outside the 90 dB attenuation points shall be equal to or greater than 90 dB.

## **B.2 Attenuation indicator**

The attenuation indicator shall have a minimum range of 80 dB and a reading accuracy of 1 dB. With a view to future regulations, an attenuation of 90 dB or more is recommended.

## **B.3 RMS value indicator**

The instrument shall accurately indicate non-sinusoidal signals in a ratio up to 10:1 between the peak value and the r.m.s. value.

## **B.4 Oscillator and amplifier**

The oscillator and the amplifier shall be designed in such a way that measurement of the adjacent channel power of a low-noise unmodulated transmitter, whose self-noise has a negligible influence on the measurement results, yields a measured value of ≤90 dB.

## Annex C (informative)

### Check list for the requirements of Clauses 4 and 5

	Satisfactory Yes/No
<b>Clause 4</b>	
<b>Construction. 4.3</b>	
Good engineering practice in respect to mechanical and electrical construction and finish	
Equipment suitable for use on board vessels	
Size of controls enable easy operation	
Number of controls suitable for simple and satisfactory operation	
Detailed operating instructions provided	
Capable of operating on single and two frequency channels with manual control (simplex)	
Operational on all channels of appendix 18 to the Radio Regulations	
Operational on all channels in annexes F, G and H	
Stored channel sets of regional variations provided	
Indicator provided of channel set in use	
Means to block access to any channel set before installation provided	
The unit indicates an incompatible working channel request	
Use of Channel 70 only possible for DSC	
Transmitter inhibited during channel switching operations and when synthesiser out of lock	
<b>Controls and Indicators 4.4</b>	
Controls impairing technical characteristic not accessible to user	
If more than one control unit is provided, priority shall be capable of being assigned to unit installed in the navigating position	
Control units shall be provided with an indication showing whether the equipment is in operation	
Distress button provided	
Call control provided	
Cancel control provided	
Cancel control automatically activated after 5 min inactivity	
Enter/Accept/OK control provided	
Means provided to easily enter a MMSI and manual position information	
Any keypad provided conforms to ITU-T E.161	
Alpha-Numeric Display provided	
On/Off switch provided for the entire installation with a visual indication that installation is in operation	
Manual non-locking push to talk switch provided	
Visual indication provided that transmitter is activated provided	
Facilities provided to limit the maximum transmission time to 5 minutes	
Switch provided for reducing transmitter power to no more than 1W with visual indication that low power selected	
Transmission of DSC distress call always at full power	
Volume control provided to adjust audiofrequency power	
Squelch control provided	
Dimming control provided of equipment illumination to zero except distress indicator	
Means provided to manually select a channel	
Channel designator provided	
Selection of channel 16 of distinctively marked	
Initial selection of channel 16 automatically selects high power	

	Satisfactory Yes/No
Means provided to enable automatic switching of a channel on receipt of a DSC call	
Default condition of automatic switching disabled	
All electronic displays including the channel designator legible irrespective of the external lighting conditions	
<b>Facilities for coding and decoding of DSC 4.5</b>	
<b>Call function 4.5.1</b>	
Quick and precise entering of call possible by the user	
Types of DSC calls given in annex A provided	
Call function permits selection of INDIVIDUAL, GROUP, ALL SHIPS URGENCY, ALL SHIPS SAFETY	
Default condition of Call function individual call	
Facilities for retrieval of stored received calls provided	
Facilities for housekeeping functions of the equipment provided	
Manual or Directory individual call can be selected	
Directory has facility for 10 entries with programmable MMSI	
<b>Manual calls 4.5.2</b>	
Manual call facility permits entry of MMSI	
If calling a Coast Station operator is requested no further information	
If calling ship operator is required to input channel number	
Equipment assists operator by making available inter-ship channels	
Default inter-ship channel is 72	
<b>Distress Calls 4.5.3</b>	
Transmission of distress call only by a dedicated distress button	
Distress button shall be red and marked DISTRESS	
The distress button shall be protect from inadvertent operation by a spring loaded cover	
Where a non transparent cover is used it shall also be marked DISTRESS	
If distress alert is activated visual indication and acoustic alarm is activated	
There is a time delay of over 3 seconds and less than 5 seconds between initiation and activation	
After transmission of distress alert the indication becomes steady	
Distress alert requires two independent actions	
Facilities are available to select nature of distress before initiation	
Default of nature of distress is undesignated distress	
Not possible to transmit nature of distress EPIRB	
Equipment is capable of receiving and displaying any nature of distress	
Initiation of distress call has priority over all other operations	
Channels 70 is selected at full power automatically	
Distress call is transmitted 5 times, in succession without interval	
Each call of 5 successive calls includes dot pattern	
DSC expansion message transmitted	
After distress call, equipment switches to channel 16 with full power automatically	
<b>All Ships calls 4.5.4</b>	
Transmission of all ships urgency and safety calls only allowed by deliberate action	
After transmission equipment switches to channel 16 with full power automatically	
<b>Incoming Calls 4.5.5</b>	
Facility to convert incoming calls to readable visual form	
Facility to store 10 DSC calls until read manually	
Capable of automatically switching to channel identified in incoming call	

	<b>Satisfactory Yes/No</b>
In the case of an incoming distress or urgency call capable of switching to Channel 16 and selecting full power automatically	
Visual indication that a channel change is requested	
<b>Other calls 4.5.6</b>	
Call types additional to those of annex A not provided	
All ships routine and Distress cancellation calls not provided	
Means for disabling automatic response to polling or position reporting calls provided	
<b>DSC Display 4.6</b>	
Display shows function currently available	
Operator is prompted if incorrect operation is attempted	
Error messages and incoming and logged calls displayed	
Visual indication of user entered information of contents of call provided	
Facilities for manual correction of user entered information of content of call	
Indication of unread incoming messages in memory provided	
Display of geographical position and time readily available	
Display shows last entered position	
Display capable of continuously displaying complete enhanced position in accordance with ITU-R M.821	
<b>Handset and loudspeaker 4.7</b>	
A telephone handset or microphone provided	
Integral loudspeaker provided	
Socket for external speaker provided	
Acoustic alarms relayed to external loudspeaker/s	
Mute is used during simplex operation	
<b>Safety 4.8</b>	
Protection against the effects of excessive current and over voltage provided	
Protection against damage due to reversal of power supply polarity provided	
Means of earthing of exposed metal parts provided	
Protection against accidental access to voltages greater than 50 V	
Protection against open circuit antenna when keyed at full power for 5 min	
Protection against short circuit antenna when keyed at full power for 5 min	
DC path from antenna terminal to chassis not exceeding 100 kOhms provided	
The information in programmable memory devices and the vessels identity and information inherent to the DSC process stored in non-volatile memory devices	
<b>Labelling 4.9</b>	
Controls, instruments, indicators and terminals clearly labelled	
Details of power supply clearly indicated	
Identification of manufacturer, type designation and serial number	
Compass safe distance is noted in manual or equipment	
<b>Warm up 4.10</b>	
After switch on the equipment is operational in less than 5 s	



	Satisfactory Yes/No
<b>Clause 5</b>	
<b>Switching time 5.1</b>	
Time necessary to switch channels does not exceed 5 s	
Time necessary to change from transmission to reception does not exceed 0,3 s	
<b>Class of emission 5.2</b>	
Phase modulation used	
25 kHz channel separation used	
<b>Facilities for DSC transmission and reception 5.3</b>	
<b>General 5.3.1</b>	
Facilities for coding and decoding DSC on channel 70 provided	
Continuous DSC watchkeeping except when transmitter is in use	
<b>Decoding 5.3.2</b>	
Decoding uses phasing, parity, time division and error check characters	
<b>Free channel transmission 5.3.3</b>	
Facilities provided to delay transmission until channel 70 free (except for distress calls)	
<b>Automatic acknowledgement 5.3.4</b>	
Automatic transmission of acknowledgements to routine calls not provided	
<b>Automatic re-transmission of distress calls 5.3.5</b>	
Facilities provided for automatic re-transmission of distress calls	
After distress call attempts equipment tunes to channel 16 with maximum power	
Automatic re-transmit sequence terminated by a distress acknowledgement	
Facilities provided to manually terminate automatic re-transmission sequence without interrupting a distress call attempt in progress	
Visual indication provided when in automatic re-transmit mode	
Audible indication provided during retransmissions	
<b>Ship identity – MMSI and Group MMSI 5.4</b>	
Capability provided of permanently storing the ship's 9 digit MMSI	
MMSI inserted automatically in the call	
10 <sup>th</sup> digit set to zero	
DSC operation inhibited until MMSI stored	
MMSI not capable of being changed by operator controls	
MMSI readily accessible to the operator	
Facilities provided to enter and store a Group MMSI	
Leading zero automatically inserted for Group MMSI	
<b>Entry of position information 5.5</b>	
Means provided for manual entry of position and time information	
Facilities provided for automatic entry of position and time information conforming with IEC 61162-1 sentences GLL, GGA, RMC and GNS	
Connected equipment is not capable of disabling the DSC equipment	
Aural and visual prompt provided for manual input of position, repeated every 4 h	
Position defaults to "9" after 23.5 h if not updated	
<b>Channel information 5.6</b>	
Channel information coded according to M.493-11 and M.1084-4	

	Satisfactory Yes/No
<b>Alarm circuits for incoming calls 5.7</b>	
<b>Distress and urgency 5.7.1</b>	
Specific acoustic alarm and visual indication provided for distress and urgency calls which activates automatically	
Disabling of alarm prevented	
Alarm not activated for duplicate distress relay calls	
<b>Other categories 5.7.2</b>	
Acoustic alarm and visual indication provided for other categories of calls which activates automatically	
Alarm distinguishable from distress and urgency alarm	
Disabling of alarm prevented	
<b>Cancellation of alarms 5.7.3</b>	
Means of manual cancellation provided	
Automatic cancellation takes place after 2 min	
<b>Acoustic alarm power 5.7.4</b>	
Alarm power distinguishable but does not interfere with communication	
Power increases to 80 db(A) after 10 s	
<b>Multiple watch facilities 5.8</b>	
<b>General 5.8.1</b>	
Multiple watch facility provided	
DSC operation takes precedence	
<b>Scanning provisions 5.8.2</b>	
Control provided to switch scanning facility on and off	
Scanning facility automatically switched off when handset off hook	
Facilities provided to change priority channel from channel 16	
Facilities provided to indicate the number of both channels operating	
Single control provided to switch to priority channel	
<b>Scanning characteristics 5.8.3</b>	
Means provided to indicate channel on which signal received	
<b>Built-in test 5.9</b>	
Built in test facility of DSC processor provided	

## Annex D (informative)

### Recommended standards for equipment operating in high level electromagnetic environments

#### D.1 Introduction

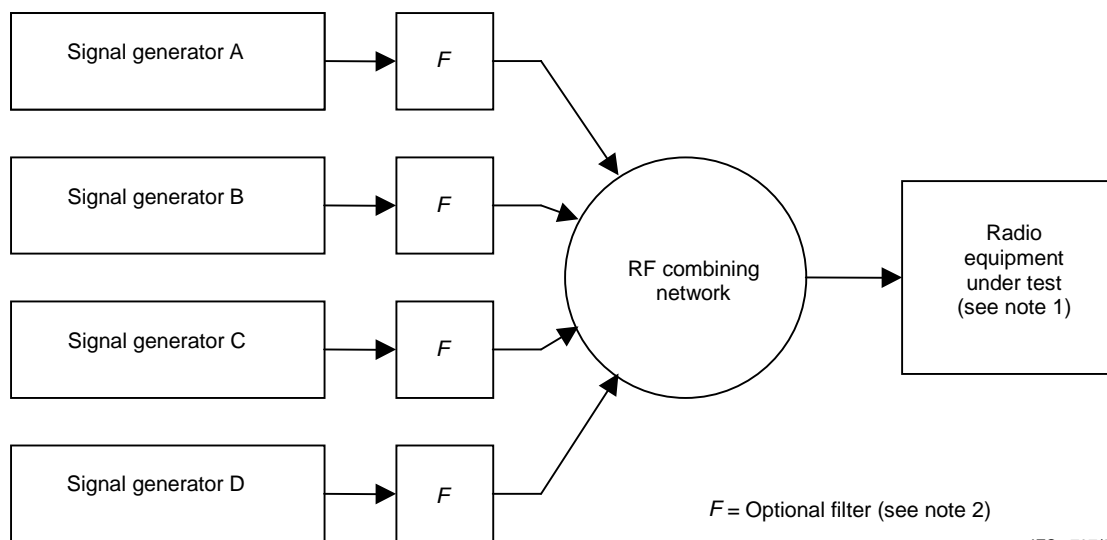
In some areas of the world, high power transmitters are located in close proximity to navigable waterways which can produce large power levels ranging from typically  $-40$  dBm to  $-10$  dBm. This has been observed, for instance, in the New Orleans/Baton Rouge waterway areas in the USA. Such power levels generate in-band nonlinear reactions, such as desensitization or intermodulation in the receiver input of greater severity than those anticipated by the blocking and intermodulation tests of this standard.

Equipment intended for use in such areas is recommended to meet the requirements of the test below. Receivers meeting the requirements below should be capable of useful reception in such environments better than 95 % of the time.

Optional circuitry accessible by operator, for example a switched RF attenuator, may be used to meet the limits required by the test.

#### D.2 Method of measurement

Four signal generators A, B, C, and D shall be connected to the receiver via a combining network as indicated in Figure D.1. Signal levels specified are measured at the RF input of the radio under test.



IEC 737/03

NOTE 1 Optional circuitry accessible by operator, for example a switched RF attenuator, may be used to meet this standard.

NOTE 2 Optional filters can be used to improve the spectral purity of the generated signals.

**Figure D.1 – Method of measurement**

*Signal generator A* – The wanted signal, represented by signal generator A, shall be set at the frequency of 156,650 MHz at +6 dB $\mu$ V(e.m.f.), (–107 dBm). The signal shall have a test modulation of 1 000 Hz at  $\pm$  3 kHz deviation.

*Signal generator B* – The first unwanted signal from signal generator B shall be adjusted to a frequency of 157,150 MHz at a signal level of +86 dB $\mu$ V(e.m.f.), (–27 dBm) at a modulation of 400 Hz at deviation  $\pm$ 3 kHz.

*Signal generator C* – The second unwanted signal from signal generator C shall be adjusted to a frequency of 157,650 MHz at +86 dB $\mu$ V(e.m.f.), (–27 dBm). The signal shall be unmodulated.

*Signal generator D* – Signal generator D shall be set to 162,375 MHz at a signal level of +98 dB $\mu$ V(e.m.f.), (–15dBm). The signal shall be unmodulated.

**Table D.1 – RF frequencies, signal levels, and modulation for signal generator**

Signal generator	Frequency	Signal level		Modulation	
	MHz	dB $\mu$ V (e.m.f.)	dBm	Frequency	Deviation
A	156,650	6	–107	1000 Hz	$\pm$ 3 kHz
B	157,150	86	–27	400 Hz	$\pm$ 3 kHz
C	157,650	86	–27	none	
D	162,375	98	–15	none	

### D.3 Limits

The SINAD ratio of the radio receiver tuned to the wanted frequency of 156,650 MHz. at the receiver audiofrequency output, psophometrically weighted, shall indicate a level no less than 14 dB, averaged over a 1 min measurement interval.

## Annex E (informative)

### International VHF marine radio channels and frequencies

*This annex is an extract of ITU Radio Regulations, appendix 18:2004.  
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NOTE See article 52 of the Radio Regulations.

NOTE For assistance in understanding the Table, see notes a) to o) below. (WRC-2000)

Channel designator	Notes	Transmitting frequencies MHz		Inter-ship	Port operations and ship movement		Public correspondence
		Ship stations	Coast stations		Single frequency	Two frequency	
60		156,025	160,625			x	x
01		156,050	160,650			x	x
61	m), o)	156,075	160,675		x	x	x
02	m), o)	156,100	160,700		x	x	x
62	m), o)	156,125	160,725		x	x	x
03	m), o)	156,150	160,750		x	x	x
63	m), o)	156,175	160,775		x	x	x
04	m), o)	156,200	160,800		x	x	x
64	m), o)	156,225	160,825		x	x	x
05	m), o)	156,250	160,850		x	x	x
65	m), o)	156,275	160,875		x	x	x
06	f)	156,300		x			
66		156,325	160,925			x	x
07		156,350	160,950			x	x
67	h)	156,375	156,375	x	x		
08		156,400		x			
68		156,425	156,425		x		
09	i)	156,450	156,450	x	x		
69		156,475	156,475	x	x		
10	h)	156,500	156,500	x	x		
70	j)	156,525	156,525	Digital selective calling for distress, safety and calling			
11		156,550	156,550		x		
71		156,575	156,575		x		
12		156,600	156,600		x		
72	i)	156,625		x			
13	k)	156,650	156,650	x	x		
73	h), i)	156,675	156,675	x	x		
14		156,700	156,700		x		
74		156,725	156,725		x		
15	g)	156,750	156,750	x	x		
75	n)	156,775			x		

Channel designator	Notes	Transmitting frequencies MHz		Inter-ship	Port operations and ship movement		Public correspondence
		Ship stations	Coast stations		Single frequency	Two frequency	
16		156,800	156,800	DISTRESS, SAFETY AND CALLING			
76	<i>n)</i>	156,825			x		
17	<i>g)</i>	156,850	156,850	x	x		
77		156,875		x			
18	<i>m)</i>	156,900	161,500		x	x	x
78		156,925	161,525			x	x
19		156,950	161,550			x	x
79		156,975	161,575			x	x
20		157,000	161,600			x	x
80		157,025	161,625			x	x
21		157,050	161,650			x	x
81		157,075	161,675			x	x
22	<i>m)</i>	157,100	161,700		x	x	x
82	<i>m), o)</i>	157,125	161,725		x	x	x
23	<i>m), o)</i>	157,150	161,750		x	x	x
83	<i>m), o)</i>	157,175	161,775		x	x	x
24	<i>m), o)</i>	157,200	161,800		x	x	x
84	<i>m), o)</i>	157,225	161,825		x	x	x
25	<i>m), o)</i>	157,250	161,850		x	x	x
85	<i>m), o)</i>	157,275	161,875		x	x	x
26	<i>m), o)</i>	157,300	161,900		x	x	x
86	<i>m), o)</i>	157,325	161,925		x	x	x
27		157,350	161,950			x	x
87		157,375			x		
28		157,400	162,000			x	x
88		157,425			x		
AIS 1	<i>l)</i>	161,975	161,975				
AIS 2	<i>l)</i>	162,025	162,025				

## Notes referring to the Table

### General notes

a) Administrations may designate frequencies in the inter-ship, port operations and ship movement services for use by light aircraft and helicopters to communicate with ships or participating coast stations in predominantly maritime support operations under the conditions specified in Nos. **51.69**, **51.73**, **51.74**, **51.75**, **51.76**, **51.77** and **51.78**. However, the use of the channels which are shared with public correspondence shall be subject to prior agreement between interested and affected administrations.

b) The channels of the present Annex, with the exception of channels 06, 13, 15, 16, 17, 70, 75 and 76, may also be used for high-speed data and facsimile transmissions, subject to special arrangement between interested and affected administrations.

c) The channels of the present Annex, but preferably channel 28 and with the exception of channels 06, 13, 15, 16, 17, 70, 75 and 76, may be used for direct-printing telegraphy and data transmission, subject to special arrangement between interested and affected administrations.

d) The frequencies in this Table may also be used for radiocommunications on inland waterways in accordance with the conditions specified in No. **5.226**.

e) Administrations having an urgent need to reduce local congestion may apply 12,5 kHz channel interleaving on a non-interference basis to 25 kHz channels, provided:

- Recommendation ITU-R M.1084-2 shall be taken into account when changing to 12,5 kHz channels;
- it shall not affect the 25 kHz channels of the present Annex maritime mobile distress and safety frequencies, especially the channels 06, 13, 15, 16, 17, and 70, nor the technical characteristics mentioned in Recommendation ITU-R M.489-2 for those channels;
- implementation of 12,5 kHz channel interleaving and consequential national requirements shall be subject to prior agreement between the implementing administrations and administrations whose ship stations or services may be affected.

### Specific notes

f) The frequency 156,300 MHz (channel 06) (see No. **51.79** and Appendices **13** and **15**) may also be used for communication between ship stations and aircraft stations engaged in coordinated search and rescue operations. Ship stations shall avoid harmful interference to such communications on channel 06 as well as to communications between aircraft stations, ice-breakers and assisted ships during ice seasons.

g) Channels 15 and 17 may also be used for on-board communications provided the effective radiated power does not exceed 1 W, and subject to the national regulations of the administration concerned when these channels are used in its territorial waters.

h) Within the European Maritime Area and in Canada, these frequencies (channels 10, 67, 73) may also be used, if so required, by the individual administrations concerned, for communication between ship stations, aircraft stations and participating land stations engaged in coordinated search and rescue and anti-pollution operations in local areas, under the conditions specified in Nos. **51.69**, **51.73**, **51.74**, **51.75**, **51.76**, **51.77** and **51.78**.

i) The preferred first three frequencies for the purpose indicated in Note a) are 156,450 MHz (channel 09), 156,625 MHz (channel 72) and 156,675 MHz (channel 73).

j) Channel 70 is to be used exclusively for digital selective calling for distress, safety and calling.

k) Channel 13 is designated for use on a worldwide basis as a navigation safety communication channel, primarily for intership navigation safety communications. It may also be used for the ship movement and port operations service subject to the national regulations of the administrations concerned.

l) These channels (AIS 1 and AIS 2) will be used for an automatic ship identification and surveillance system capable of providing worldwide operation on high seas, unless other frequencies are designated on a regional basis for this purpose.

m) These channels may be operated as single frequency channels, subject to special arrangement between interested or affected administrations. (WRC-2000)

n) The use of these channels (75 and 76) should be restricted to navigation-related communications only and all precautions should be taken to avoid harmful interference to channel 16, e.g. by limiting the output power to 1 W or by means of geographical separation.

o) These channels may be used to provide bands for initial testing and the possible future introduction of new technologies, subject to special arrangement between interested or affected administrations. Stations using these channels or bands for the testing and the possible future introduction of new technologies shall not cause harmful interference to, and shall not claim protection from, other stations operating in accordance with Article 5. (WRC-2000)

## Annex F (informative)

### U.S. VHF marine radio channels and frequencies

Channel number	Ship Transmit MHz	Ship Receive MHz	Use
01A	156,050	156,050	Port Operations and Commercial, VTS. Available only in New Orleans / Lower Mississippi area.
05A	156,250	156,250	Port Operations or VTS in the Houston, New Orleans and Seattle areas.
06	156,300	156,300	Intership Safety
07A	156,350	156,350	Commercial
08	156,400	156,400	Commercial (Intership only)
09	156,450	156,450	Boater Calling. Commercial and Non-Commercial.
10	156,500	156,500	Commercial
11	156,550	156,550	Commercial. VTS in selected areas.
12	156,600	156,600	Port Operations. VTS in selected areas.
13	156,650	156,650	Intership Navigation Safety (Bridge-to-bridge). Ships >20m length maintain a listening watch on this channel in US waters.
14	156,700	156,700	Port Operations. VTS in selected areas.
15	--	156,750	Environmental (Receive only). Used by Class C EPIRBs.
16	156,800	156,800	International Distress, Safety and Calling. Ships required to carry radio, USCG, and most coast stations maintain a listening watch on this channel.
17	156,850	156,850	State Control
18A	156,900	156,900	Commercial
19A	156,950	156,950	Commercial
20	157,000	161,600	Port Operations (duplex)
20A	157,000	157,000	Port Operations
21A	157,050	157,050	U.S. Coast Guard only
22A	157,100	157,100	Coast Guard Liaison and Maritime Safety Information Broadcasts. Broadcasts announced on channel 16.
23A	157,150	157,150	U.S. Coast Guard only
24	157,200	161,800	Public Correspondence (Marine Operator)
25	157,250	161,850	Public Correspondence (Marine Operator)
26	157,300	161,900	Public Correspondence (Marine Operator)
27	157,350	161,950	Public Correspondence (Marine Operator)
28	157,400	162,000	Public Correspondence (Marine Operator)
63A	156,175	156,175	Port Operations and Commercial, VTS. Available only in New Orleans / Lower Mississippi area.
65A	156,275	156,275	Port Operations
66A	156,325	156,325	Port Operations
67	156,375	156,375	Commercial. Used for Bridge-to-bridge communications in lower Mississippi River. Intership only.
68	156,425	156,425	Non-Commercial



69	156,475	156,475	Non-Commercial
70	156,525	156,525	Digital Selective Calling (voice communications not allowed)
71	156,575	156,575	Non-Commercial
72	156,625	156,625	Non-Commercial (Intership only)
73	156,675	156,675	Port Operations
74	156,725	156,725	Port Operations
77	156,875	156,875	Port Operations (Intership only)
78A	156,925	156,925	Non-Commercial
79A	156,975	156,975	Commercial. Non-Commercial in Great Lakes only
80A	157,025	157,025	Commercial. Non-Commercial in Great Lakes only
81A	157,075	157,075	U.S. Government only – Environmental protection operations.
82A	157,125	157,125	U.S. Government only
83A	157,175	157,175	U.S. Coast Guard only
84	157,225	161,825	Public Correspondence (Marine Operator)
85	157,275	161,875	Public Correspondence (Marine Operator)
86	157,325	161,925	Public Correspondence (Marine Operator)
87	157,375	161,975	Public Correspondence (Marine Operator)
88	157,425	162,025	Public Correspondence only near Canadian border.
88A	157,425	157,425	Commercial, Intership only.

Note that the letter “A” indicates simplex use of the ship station transmit side of an international duplex channel, and that operations are different from that of international operations on that channel. Some VHF transceivers are equipped with an “International – U.S.” switch for that purpose. “A” channels are generally only used in the United States, and use is normally not recognized or allowed outside the U.S. The letter “B” indicates simplex use of the coast station transmit side of an international duplex channel. The U.S. does not currently use “B” channels for simplex communications in this band.

Boaters should normally use channels listed as Non-Commercial. Channel 16 is used for calling other stations or for distress alerting. Channel 13 should be used to contact a ship when there is danger of collision. All ships of length 20 m or greater are required to guard VHF channel 13, in addition to VHF channel 16, when operating within U.S. territorial waters

### NOAA Weather Radio Frequencies

Weather channel	Frequency MHz
WX1	162,550
WX2	162,400
WX3	162,475
WX4	162,425
WX5	162,450
WX6	162,500
WX7	162,525

**Annex G**  
(informative)

**CANADIAN VHF marine radio channels and frequencies**

Item	Column I International channel designators	Column II Frequencies MHz		Column III Nature of Service					Column IV Type of Traffic		Column V Area of operation	Column VI Restrictions (notes and remarks)
		Transmit	Receive	Inter- ship	Ship/ Shore	Commer- cial	Non- commer- cial	Safety	Ship move- ment	Public corres- pondence		
1	01	156,050	160,650							X	PC	
2	02	156,100	160,700							X	PC	
3	03	156,150	160,750							X	PC	
4	04A	156,200	156,200	X	X			X			PC	Canadian Coast Guard search and rescue.
5	04A	156,200	156,200	X	X	X					EC	Commercial fishing only.
6	05A	156,250	156,250						X			
7	06	156,300	-----	X		X	X	X			All areas	May be used for search and rescue communications between ships and aircraft.
8	07A	156,350	156,350	X	X	X					All areas	
9	08	156,400	-----	X		X		X			WC, EC	Also assigned for operations in the Lake Winnipeg area.
10	09	156,450	156,450	X	X	X	X		X		AC	May be used to communicate with aircraft and helicopters in predominantly maritime support operations.
11	10	156,500	156,500	X	X	X	X	X	X		AC, GL	May also be used for communications with aircraft engaged in coordinated search and rescue and antipollution operations.
12	11	156,550	156,550	X	X	X	X		X		PC, AC, GL	Also used for pilotage purposes.

Item	Column I International channel designators	Column II Frequencies MHz		Column III Nature of Service					Column IV Type of Traffic		Column V Area of operation	Column VI Restrictions (notes and remarks)
		Transmit	Receive	Inter- ship	Ship/ Shore	Commer- cial	Non- commer- cial	Safety	Ship move- ment	Public corres- pondence		
13	12	156,600	156,600	X	X	X	X		X		WC, AC, GL	Port operations and pilot information and messages.
14	13	156,650	156,650	X		X	X		X		All Areas	Exclusively for bridge-to-bridge navigational traffic.
15	14	156,700	156,700	X	X	X	X		X		AC, GL	Port operations and pilot information and messages.
16	15	156,750	156,750	X	X	X	X		X		All areas	All operations limited to 1-watt maximum power. May also be used for on-board communications.
17	16	156,800	156,800	International Distress, Safety and Calling.							All areas	
18	17	156,850	156,850	X	X	X	X		X		All areas	All operations limited to 1-watt maximum power. May also be used for on-board communications.
19	18A	156,900	156,900	X	X	X					All areas	Towing on the Pacific Coast.
20	19A	156,950	156,950	X	X						All areas except PC	Canadian Coast Guard only.
21	19A	156,950	156,950	X	X						PC	Various Government departments.
22	20	157,000	161,600		X			X	X		All areas	Port operations only with 1-watt maximum power.
23	21A	157,050	157,050	X	X						All areas	Canadian Coast Guard only.
24	21B	-----	161,650					X			All areas	Continuous Marine Broadcast (CMB) service.
25	22A	157,100	157,100	X	X	X	X				All areas	For communications between Canadian Coast Guard and non-Canadian Coast Guard stations only.
26	23	157,150	161,750		X					X	PC	Also in the inland waters of

Item	Column I International channel designators	Column II Frequencies MHz		Column III Nature of Service					Column IV Type of Traffic		Column V Area of operation	Column VI Restrictions (notes and remarks)
		Transmit	Receive	Inter- ship	Ship/ Shore	Commer- cial	Non- commer- cial	Safety	Ship move- ment	Public corres- pondence		
												British Columbia and the Yukon.
27	24	157,200	161,800		X					X	All areas	
28	25	157,250	161,850		X					X	PC	Also assigned for operations in the Lake Winnipeg area.
29	25B	-----	161,850					X			AC	Continuous Marine Broadcast (CMB) service.
30	26	157,300	161,900		X			X		X	All areas	
31	27	157,350	161,950		X					X	AC, GL, PC	
32	28	157,400	162,000		X			X		X	PC	
33	28B	-----	162,000								AC	Continuous Marine Broadcast (CMB) service.
34	60	156,025	160,625		X					X	PC	
35	61A	156,075	156,075	X	X						PC	Canadian Coast Guard only.
36	61A	156,075	156,075	X	X	X					EC	Commercial fishing only.
37	62A	156,125	156,125	X	X						PC	Canadian Coast Guard only.
38	62A	156,125	156,125	X	X	X					EC	Commercial fishing only.
39	64	156,225	160,825		X					X	PC	
40	64A	156,225	156,225	X	X	X					EC	Commercial fishing only.
41	65A	156,275	156,275	X	X	X	X	X				Search and rescue and antipollution operations on the Great Lakes. Towing on the Pacific Coast. Port operations only in the St. Lawrence River areas with 1-watt maximum power. Pleasure craft in the inland waters of Alberta, Saskatchewan and Manitoba (excluding Lake Winnipeg and the Red River).

Item	Column I International channel designators	Column II Frequencies MHz		Column III Nature of Service					Column IV Type of Traffic		Column V Area of operation	Column VI Restrictions (notes and remarks)
		Transmit	Receive	Inter- ship	Ship/ Shore	Commer- cial	Non- commer- cial	Safety	Ship move- ment	Public corres- pondence		
42	66A	156,325	156,325	X	X	X	X	X	X			Port operations only in the St. Lawrence River/Great Lakes Areas with 1-watt maximum power.
43	67	156,375	156,375	X	X	X					EC	Commercial fishing only.
44	67	156,375	156,375	X	X	X	X	X			All areas except EC	May also be used for communications with aircraft engaged in coordinated search and rescue and antipollution operations.
45	68	156,425	156,425	X	X		X				All areas	For marinas and yacht clubs.
46	69	156,475	156,475	X	X	X	X				All areas except EC	
47	69	156,475	156,475	X	X	X					EC	Commercial fishing only.
48	70	156,525	156,525	Digital Selective Calling for Distress, Safety and Calling.								
49	71	156,575	156,575	X	X	X	X	X	X		PC	
50	71	156,575	156,575	X	X		X					For marinas and yacht clubs on the East Coast and on Lake Winnipeg.
51	72	156,625	-----	X		X	X				EC, PC	May be used to communicate with aircraft and helicopters in predominantly maritime support operations.
52	73	156,675	156,675	X	X	X					EC	Commercial fishing only.
53	73	156,675	156,675	X	X	X	X	X			All areas except EC	May also be used for communications with aircraft engaged in coordinated search and rescue and antipollution operations.
54	74	156,725	156,725	X	X	X	X		X		EC, PC	
55	75	Not available – Guard band for Channel 16										

Item	Column I International channel designators	Column II Frequencies MHz		Column III Nature of Service					Column IV Type of Traffic		Column V Area of operation	Column VI Restrictions (notes and remarks)
		Transmit	Receive	Inter- ship	Ship/ Shore	Commer- cial	Non- commer- cial	Safety	Ship move- ment	Public corres- pondence		
56	76	Not available – Guard band for Channel 16										
57	77	156,875	156,875	X	X			X	X			Pilotage on Pacific Coast. Port operations only in the St. Lawrence River/Great Lakes areas with 1-watt maximum power.
58	78A	156,925	156,925	X	X	X					EC, PC	
59	79A	156,975	156,975	X	X	X					EC, PC	
60	80A	157,025	157,025	X	X	X					EC, PC	
61	81A	157,075	157,075	X	X							Canadian Coast Guard use only in the St. Lawrence River/Great Lakes areas.
62	81A	157,075	157,075	X	X			X			PC	Canadian Coast Guard antipollution.
63	82A	157,125	157,125	X	X			X			PC	Canadian Coast Guard use only.
64	82A	157,125	157,125	X	X							Canadian Coast Guard use only in the St. Lawrence River/Great Lakes areas.
65	83	157,175	161,775		X			X			PC	Canadian Coast Guard use only.
66	83A	157,175	157,175	X	X						EC	Canadian Coast Guard and other Government agencies.
67	83B	-----	161,775					X			AC, GL	Continuous Marine Broadcast (CMB) Service.
68	84	157,225	161,825		X					X	PC	
69	85	157,275	161,875		X					X	AC, GL, NL	
70	86	157,325	161,925		X					X	PC	
71	87	157,375	161,975		X					X	AC, GL, NL	
72	88	157,425	162,025		X					X	AC, GL, NL	

Item	Column I International channel designators	Column II Frequencies MHz		Column III Nature of Service					Column IV Type of Traffic		Column V Area of operation	Column VI Restrictions (notes and remarks)
		Transmit	Receive	Inter- ship	Ship/ Shore	Commer- cial	Non- commer- cial	Safety	Ship move- ment	Public corres- pondence		
73	WX1	-----	162,550					X			EC, PC	Continuous Marine Broadcast (CMB) Service.
74	WX2	-----	162,400					X			EC, PC	Continuous Marine Broadcast (CMB) Service.
75	WX3	-----	162,475					X			EC, PC	Continuous Marine Broadcast (CMB) Service.
EC (East Coast): includes NL, AC, GL and Eastern Arctic areas WC (West Coast): Pacific Coast, Western Arctic and Athabasca-Mackenzie Watershed areas NL: Newfoundland and Labrador								AC: PC: All areas: GL:	Atlantic Coast, Gulf and St. Lawrence River up to and including Montreal Pacific Coast includes East and West Coast areas Great Lakes (including St. Lawrence above Montreal)			

Annex H  
(informative)

European VHF marine radio channels and frequencies

	Austria Sea	Austria IW	Belgium Sea	Belgium IW	Denmark Pleasure	Denmark Fishing	Eire	Finland Fishing	Finland Pleasure	France Sea	France IW	Germany Sea	Germany IW	Greece	Holland Sea	Holland IW	Iceland	Italy	Norway Fishing	Norway Pleasure	Portugal	Spain	Sweden Fishing	Sweden Pleasure	UK
International channels																									
M & M2																									
channel 31 (Tx 157.550 MHz/Rx162.150 MHz)																									
channel 96 (Tx 162.425 MHz/Rx162.425 MHz)																									
channel 37 (Tx /Rx 157.850 MHz)																									
L1 L2																									
L1, L2, L3																									
F1, F2, F3.																									
NOTE	M (Tx /Rx 157.850 MHz)				M2 (Tx /Rx 161.425 MHz)				L3 (Tx /Rx 155.650 MHz)																
	L1 (Tx /Rx 155.500 MHz)				L2 (Tx /Rx 155.525 MHz)				F3 (Tx /Rx 155.825 MHz)																
	F1 (Tx /Rx 155.625 MHz)				F2 (Tx /Rx 155.775 MHz)																				